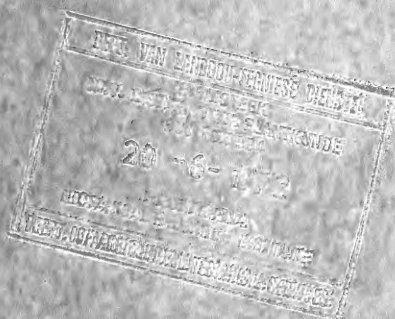



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**JOURNAL  
OF  
SOUTH AFRICAN  
BOTANY**

**VOLUME 36**

**1970**

*Published under the authority  
of the*

**Trustees  
of the  
National Botanic Gardens  
of  
South Africa.  
Kirstenbosch,  
Newlands, C.P.**

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APC 17-199  
5/6



# JOURNAL OF SOUTH AFRICAN BOTANY

VOLUME 36

1970

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THIS VOLUME IS DEDICATED TO

ADOLF J. W. BAYER (1900— )

D.Sc., Hon. D.Sc (Natal), F.R.S.S. Af.

(*Head: Department of Botany, University of Natal, 1939—1966*)

several times Dean of the Faculty of Science and Representative on Council and other Committees, a notable teacher of the Science of Botany in South Africa, many of his students being, today, highly esteemed leaders in their fields, author of publications dealing with various aspects of the vegetation of Natal, an active member of many official bodies, including the Union Botanical Survey, South African Association for the Advancement of Science, the Board of Trustees of the Natal Museum and the Natal Examinations Board, the Wattle Research Institute and the St Lucia Lake Commission, President of the Botanic Society of Natal and, in 1969, made an Hon. Life Member of the Botanical Society of South Africa in recognition of his services in helping to bring the Natal Botanic Garden under the control of the National Botanic Gardens of South Africa.



## DIE HERONTDEKTE *ROMULEA MONADELPHA*

Miriam P. de Vos

(Departement van Plantkunde, Universiteit van Stellenbosch)

### SAMEVATTING

Die geskiedenis van *Romulea monadelpha* (Sweet) Baker wat slegs bekend was uit 'n beskrywing en gekleurde tekening, en die herontdekking daarvan in 1964, word geskets. 'n Beskrywing van die soort word gegee en die resultate van kruisingseksperimente tussen *R. monadelpha* en *R. sabulosa* Beg. word bespreek. Daar word aan die hand gedoen dat hierdie twee verwante soorte in dieselfde seksie van die genus tuis behoort.

### ABSTRACT

THE REDISCOVERED *ROMULEA MONADELPHA*.—The history of *Romulea monadelpha* (Sweet) Baker, known only from a description and coloured drawing of it, and its rediscovery in 1964, are sketched. The species is described and the results of hybridisation experiments between *R. monadelpha* and *R. sabulosa* Beg. are discussed. It is suggested that these two allied species belong to the same section of the genus.

### GESKIEDENIS

In 1825 het Synnot 'n paar knolle van *Romulea monadelpha* (Sweet) Baker van die Kaap na Engeland gebring, waar twee van die plante in Colvill se kwekery geblom het, kort nadat hulle geplant is. Hulle het egter geen saad gevorm nie en het ook nie weer geblom nie (Sweet 1837). In 1829 het Sweet 'n gekleurde tekening en beskrywing van die plant gepubliseer onder die naam *Spatalanthus speciosus* Sweet.

Die jaar daarop het hy die species na die genus *Trichonema* (die destydse naam vir *Romulea*) oorgeplaas, as *T. monadelphum*—aangesien die naam *T. speciosum* reeds beset was. Maar in 1837 het hy dit weer terug gebring na *Spatalanthus speciosus*, want, meld hy: "we have no doubt but it will form a distinct genus from any already published, differing from *Trichonema*, to which it is nearest in habit, by its monadelphous stamens, and very distinct stigmas, and probably also by its seeds; and we know no other genus with which we need compare it".

Baker (1892) het die species na die genus *Romulea* oorgeplaas, niesteenstaande die vergroeide helmdrade. Hy het besef dat die stempels, deur Sweet beskryf as "... three flat ligulate stigmas that are forked at the tips", dikwels

tipies is vir *Romulea*. In 1896 plaas hy die soort in 'n eie subgenus *Spathalanthus* onder die genus *Romulea*, met die kenmerke: helmdrade tot die top vergroei in 'n buis.

Omdat die vindplek in Suid-Afrika onbekend was, is die spesies vir meer as 130 jaar bekend gewees alleen uit Sweet se beskrywing en gekleurde tekening wat ook die tipe is—g'n herbariumeksemplaar van Sweet kon opgespoor word nie.

Na die ontdekking van *R. sabulosa* Beg. (1907) met 'n blomdek tot 'n mate soos dié van Sweet se tekening, maar met vrye helmdrade wat styf teenmekaar staan, is aan die hand gedoen dat Sweet verkeerdelik die helmdrade as vergroei aangegee het (Béguinot 1909). Béguinot (p. 84) het *R. monadelpha* verder as 'n sinoniem van *R. pudica* Baker beskou, nog 'n spesies wat bekend is slegs uit 'n beskrywing en 'n gekleurde tekening. Hierdie sienswyse is onaanneemlik aangesien die twee tekeninge te veel verskil.

In 1964, op 'n soektog na *R. sabulosa* in die Calvinia-distrik, is plante 'n paar myl oos van Nieuwoudtville versamel wat oppervlakkig soveel op *R. sabulosa* gelyk het, dat hulle assulks beskou is. Gelukkig is hulle by die Universiteit van Stellenbosch gekweek en die volgende jaar, toe hulle weer blom, is opgemerk dat hulle vergroeiende helmdrade besit en die lank vermiste *R.*



FIG. 1.

Die blomme van *Romulea monadelpha*, byna natuurlike grootte.

*monadelpha* is. Hulle verskil van Sweet se figuur in die korter en breër blomdeklare wat selfs in die oop blom mekaar met hul rande oorvleuel en aan die blom 'n meer kompakte vorm gee (Fig. 1). Die langer blomdeklare in Sweet se afbeelding het moontlik verskyn as gevolg van minder skerp lig. Sulke lang blomdeklare ontwikkel ook soms in Stellenbosch wanneer die plante in gedeeltelike skaduwee gekweek word.

#### BESKRYWING VAN DIE SPECIES

**R. monadelpha** (Sweet) Baker, Handb. Irid. 104 (1892), et 1896 p. 43; Béguinot 1909 p. 83 pro syn. *Spatalanthus speciosus* Sweet 1829 t.300 et 1837 t.300; Béguinot 1909 p. 83 pro syn. *Trichonema monadelphum* Sweet 1830 p. 399; Béguinot 1909 p. 83 pro syn.

*Knol* asymmetries, 8—15 mm in deursnee, met harde gladde bruin tunicae wat aan die basis gesplits is in lang skerp tande wat na eenkant gebuig is, en aan die top in kort vesels. *Stingel* kort, verberg deur die blaarskedes. *Blare* 3—5, basal, filiform, 100—300 mm lank, ongeveer 1 mm in deursnee, met vier smal huidmondjiedraende groewe, min of meer regop of gebuig, blaarskedes 5—6 mm wyd. *Bloeistele* 40—100 mm lank, halfronde, elk met 'n enkele topstandige blom ingesluit in twee hoogteblare. *Skutblaar* sterk, groen, met smal gewoonlik bruin, vliesige rande, eiervormig, konkaaf, 20—30 mm lank, met 'n sterker middelaar in die boonste helfte. *Skutblaartjie* effens smaller en dikwels effens langer, groen met vliesige rande wat bruin in die boonste helfte is, met 2 kiele en 2 sterker are daarop. *Blomme* 1—4, 30—45 mm en soms tot 55 mm lank, min of meer klokvormig. *Blomdeklare* aan die basis vir 2—3 mm vergroei tot 'n vlak pieringvormige skyfie met 'n sespuntige, wit stervormige merk daarin, min of meer rombies-wigvormig tot omgekeerd eiervormig-wigvormig, teruggebui, 12—25 mm wyd, diep kersierooi, blink, op elke klou 'n mediane spiesvormige swart kol omring deur 'n blou of gryserige of soms liggeel area en daaronder 'n geel kol (wat in gedroogde eksemplare verbleik); die buitenste lobbe agter met 5—7 geel lengteare en fyn veervormige aartjies. *Meeldrade* eenbroederig, ingeplant in die basis van die blomdek; *helmdrade* 3—4 mm lank, vergroei tot 'n kort, blinkswart buis; *helmknoppe* vry maar vereers aan die toppe vergroei, 10—15 mm lank, krom, met goudgeel stuifmeel. *Vrugbeginsel* 3—5 mm lank; *styl* 8—12 mm lank; *stempels* 6, tot die helfte of tot driekwart van die helmknoppe reikend. *Doosvrug* 10—15 mm lank, kort silindries, bedek deur die blywende skutblaar en skutblaartjie, op 'n gekromde bloeias.

*Chromosoomgetal*:  $2n = 26$  (de Vos 1926, 1991)

*Tipe*: Sweet, Brit. Flow. Gard. t.300 (1829).

**KAAP—3119** (Calvinia): Ongeveer 3 ml. Oos van Nieuwoudtville, de Vos 1926, 1991; Naby Nieuwoudtville, Burger (STE 30206 gedeeltelik). 10 ml. van

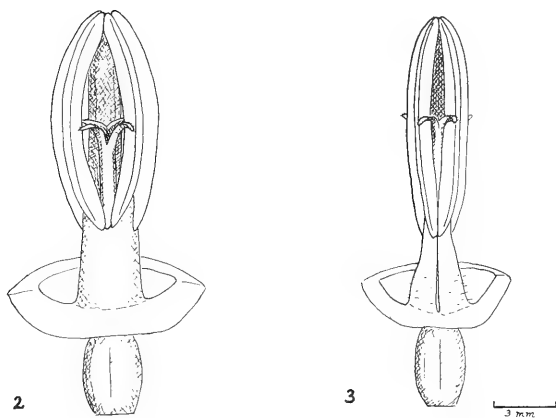


FIG. 2.

Die meeldrade, stamper en basis van die blomdek van *Romulea monadelphica*,  $\times 3$ .

FIG. 3.

Die meeldrade, stamper en basis van die blomdek van *Romulea sabulosa*,  $\times 3$ .

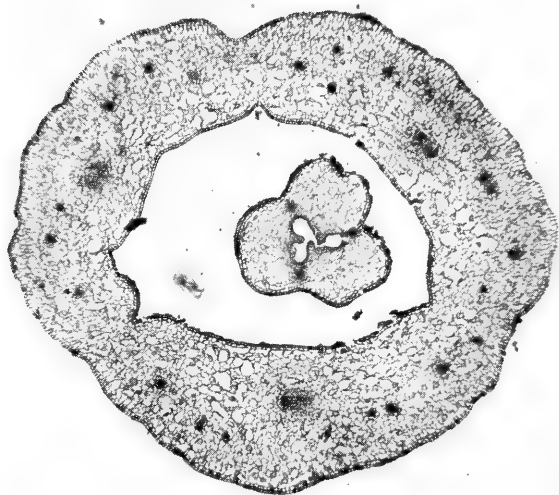


FIG. 4.

Dwarssnee deur die helmdraadbuys en styl van *Romulea monadelphica*.



Calvinia na Nieuwoudtville, *Hardy 64* (PRE). Akkerdam, aan die voet van die Hantamberge, *Middelmost 2160* (NBG).

Blomtyd: einde Julie tot September.

*R. monadelpha* en *R. sabulosa* is sympatries en naverwant en die twee spesies kan met 'n oppervlakkige ondersoek maklik verwar word (Fig. 1, 5). Hulle toon dieselfde chromosoomgetal, knoltipe, kort stingel en blaaranatomie, dieselfde tipe skutblaar en skutblaartjie, stempels, blomdekvorm en -grootte, en byna dieselfde blomdekkleur en merke. *R. monadelpha* verskil hoofsaaklik in sy vergroeide helmdrade (Fig. 2, 3, 4), asook in sy halfronde bloeisteel wat na die antese effens afbuig, en in 'n effens meer briljante rooi blomdek met klein verskille by die kolle in die keel. 'n Noukeurige ondersoek van alle herbariummateriaal wat as *R. sabulosa* geïdentifiseer is, het onder hulle 'n paar *R. monadelpha*'s in NBG en PRE aangetoon (sien hierbo).

Beide spesies word in die Nieuwoudtville-distrik satynblom of syblom genoem weens hul blinkrooi blomdek, maar boere op wie se plase albei voorkom, weet dat hulle verskillende soorte is.

#### EKSPERIMENTELE WERK

Om die verwantskap tussen die twee spesies *R. monadelpha* en *R. sabulosa* te ondersoek, is kruisingseksperimente tussen hulle gedoen in 1966. Beide



FIG. 5.

Die blom van *Romulea sabulosa*, byna natuurlike grootte.



FIG. 6.

Die blom van die *Romulea monadelpha*  $\times$  *R. sabulosa*-baster, effens vergroot.

soorte kruisings is uitgevoer, met *R. monadelpha* en met *R. sabulosa* as stuifmeelontvanger. Tussen 12 en 15 skynbaar vrugbare saad per vrug is uit die kruisings verkry, en in 1967 het ongeveer die helfte van die sade ontkiem. Die jaar daarop het die basterplante reeds gebloom (Fig. 6)—dit is die gewone toestand dat *Romulea*-plante reeds in hul tweede groeiseisoen blom.

Die blomme van die basterplante het vry helmdrade wat ôf geel ôf swart is, of in enkele gevalle intermediêr, 'n blomdek met die kleur van *R. monadelpha* maar merke meer soos die van *R. sabulosa*, en 'n bloeisteel min of meer tussenin (tabel 1). Hul stuifmeel was van 25% tot 65% klaarblyklik abortief.

Die kruisings toon dat die twee spesies waarskynlik met verskeie allele van mekaar verskil en dat daar waarskynlik meer as een mutasie moes plaasgevind het, indien *R. monadelpha* van *R. sabulosa* ontstaan het—wat heel moontlik is as die eendersheid van die twee spesies in ag geneem word.

Met *R. monadelpha* as stuifmeelontvanger was die meeste helmdrade swart, en met *R. sabulosa* as vroulike ouer was meeste helmdrade geel of in 'n paar gevalle vaal of swart-gestreep. Dit toon dat die oorerwing van die helmdraadkleur kompleks is, en dat die sitoplasma moontlik ook as faktor daarby betrokke kan wees.

TABEL 1.

Die onderskeidende kenmerke van *Romulea monadelpha*, *R. sabulosa*, en hul kruisings-produk

	<i>R. monadelpha</i>	<i>Basters</i>	<i>R. sabulosa</i>
Helmdrade	Vergroei	Vry	Vry
Helmdrade	Swart	Geel of swart	Geel
Helmknoppe	Gekrom	Effens krom	± Reguit
Bloeias	Semitereet	Intermediër	Subtereet
Blomdek	Kersierooi	Kersierooi	Meer oranjerooi

Die aparte subgenus *Spathalanthus* Baker (1896) vir *R. monadelpha* is te regverdig wanneer slegs die morfologie in aanmerking geneem word. Maar in 'n taksonomiese sisteem wat die natuurlike verwantskappe wil probeer aantoon, behoort die twee spesies in één seksie te wees en nie in aparte subgenera nie. In die sistematiese hersiening van die genus waaraan nou gewerk word, sal hulle in één seksie geplaas word.

In 1968 is kruisbestuiwings tussen F1-basterplante uitgevoer en slegs ses tot twaalf oënskynlik normale saad per vrug is verkry—dus heelwat minder saad as wat ná die eerste kruisings verkry is. Ongeveer die helfte tot drie-kwart van hierdie sade het in die huidige seisoen ontkiem en moontlik sal hulle aanstaande jaar blom.

Daar basters so maklik eksperimenteel verkry kan word, is dit moontlik dat hulle ook in die veld mag voorkom want die plante is simpatries. Sulke basters sou dan vir *R. sabulosa* aangesien kan word, weens hulle vry helmdrade.

#### BEDANKINGS

My hartlike dank gaan aan mev. H. M. Burger van Nieuwoudtville, mej. A. Uys en dr. Elsabe Malan, beide van die Universiteit van Stellenbosch wat almal met die versameling van die plante gehelp het, die W.N.N.R. vir 'n navorsingstoelae, die hoofde van die bogenoemde herbaria en die vele ander herbaria vir verlof om hul plantmateriaal te ondersoek, die tegniese personeel van die Plantkunde-departement van Stellenbosch vir hul hulp en aan Prof. P. G. Jordaan vir die oorlees van die manuskrip.

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## **SPIRODELA GROWTH TEST: A POSSIBLE BIOASSAY FOR ABSCISIC ACID\***

Johannes van Staden and Chris H. Bornman

(Department of Botany, University of Natal, Pietermaritzburg)

### **ABSTRACT**

The growth response of *Spirodela oligorrhiza* in terms of dry weight production over a period of eight days is proportional to the  $\log_{10}$  concentration of ABA and can be used as a sensitive, reliable and easily performed bioassay to detect amounts as low as  $10^{-5} \mu\text{g}$ . The assay is particularly reliable over the range 0.01 to  $10,000 \mu\text{g}$ .

### **UITTREKSEL**

**SPIRODELLA GROEITOETS:** 'n MOONTLIKE BIOLOGIESE METING VIR AFSNYDINGSSTAD. Die groei reaksie van *Spirodela oligorrhiza* in terme van droë gewig produksie oor 'n tydperk van agt dae is eweredig met die  $\log_{10}$  konsentrasie van ABA en kan gebruik word as 'n sensitiewe, betroubare en maklik uitvoerbare biologiese meting om hoeveelhede so min as  $10^{-5} \mu\text{g}$  te bepaal. Die meting is veral betroubaar oor die reeks 0.01 tot  $10,000 \mu\text{g}$ .

### **INTRODUCTION**

Ohkuma, Smith, Lyon and Addicott (1963) reported on the use of the standard cotton explant bioassay to test the phenomenal abscission-accelerating properties of ABA. However, this bioassay, which employs the cotyledonary petioles of 14-day old cotton seedlings, also responds to ethylene and gibberellic acid. Milborrow (1967) described a bioassay in which the effect of ABA on coleoptile length in dissected wheat embryos was measured. He also developed a sophisticated racemate dilution method which, unfortunately, requires rather specialized equipment. Davis, Heinz and Addicott (1968) recently described a chemical assay using a gas-liquid chromatographic method to measure the trimethylsilyl derivatives of ABA.

The bioassay reported on here, involves the minimum of equipment; it is easily performed, but it does require a rather long culture period, namely eight days.

---

Accepted for publication 1st October, 1969.

\* This research was supported by a grant from the Council for Scientific and Industrial Research, Pretoria, Republic of South Africa.

## MATERIAL AND METHODS

Three sterile, two-frond plants of *Spirodela oligorrhiza* were selected for uniformity of stage of development and size, and transferred aseptically to each of 50ml Erlenmeyer flasks containing 30ml full strength Hoagland's nutrient medium with the appropriate dilution of ABA. Dilutions of ABA were made up with nutrient solution. Each flask was connected to a Swinnex adapter fitted with a GS 0.22 $\mu$  filter disc and sterilized at 1.05kg/cm<sup>2</sup> for 15 minutes. The cultures were aerated for 45 minutes twice daily and were illuminated for 16 hours per day with fluorescent light at an intensity of ca.  $3.0 \times 10^3$  lm/m<sup>2</sup>. Each experiment was terminated after either eight or twelve days, as preliminary experiments had shown that longer periods of time (e.g. up to 21 days) were unsuitable as they gave very variable results.

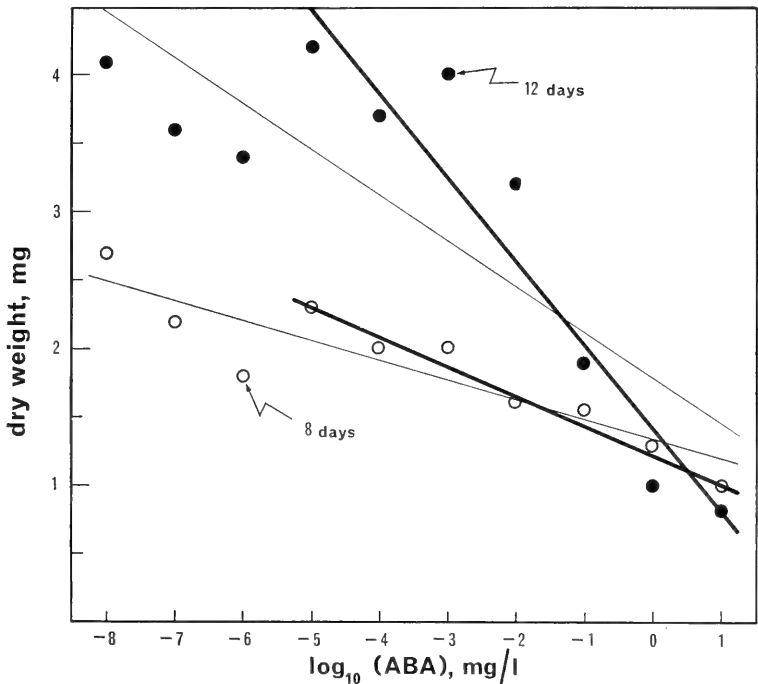


FIG. 1.

The relationship between the dry weight of *Spirodela* and the concentration of abscisic acid.

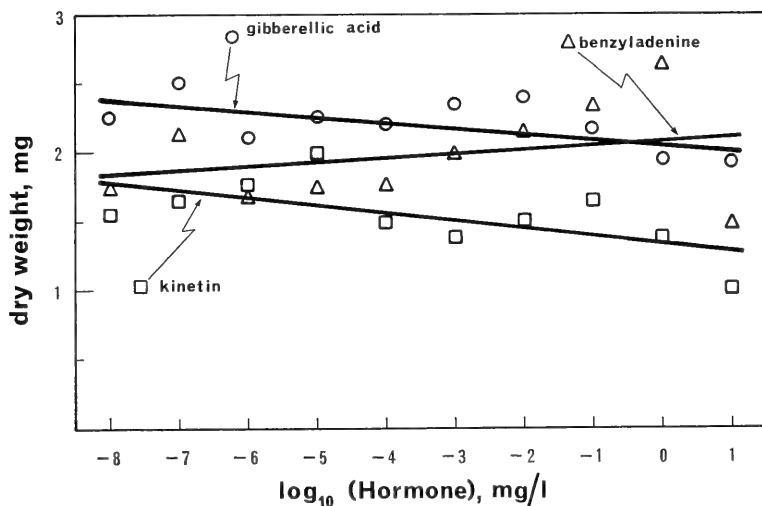


FIG. 2.

The relationship between the dry weight of *Spirodela* and the concentration of gibberellic acid, kinetin and benzyladenine.

The results reported in this paper are from six experiments with six three-plant replicates in each treatment. The same procedure was followed to determine the effects of kinetin, benzyladenine (BA) and gibberellic acid (GA) on the growth of *Spirodela*.

## RESULTS AND DISCUSSION

The relationship between dry weight of *Spirodela* and concentration of abscisic acid for eight and twelve day growth periods are shown in Figure 1 and the relationship between dry weight and concentration of gibberellic acid, benzyladenine and kinetin are shown in Figure 2. For the eight day growth results the regression line fitted to the range of concentrations of ABA from  $10^{-5}$  to  $10\text{mg/l}$  gave a better fit than when a line was fitted to the whole range ( $10^{-8}$  to  $10\text{mg/l}$ ). The same applied to the results obtained for a twelve day growth period (Figure 1). A point to note is that the break between  $10^{-6}$  and  $10^{-5}$  mg/l of ABA has been obtained in repeated experiments and was reported earlier (Van Staden *et al.* 1969).

The usable range of this assay is therefore from  $0.01$  to  $10,000\mu\text{g}$ , which is reasonable if it is taken into account that in the test of Davis *et al.* (1968) the lowest concentration of ABA detectable was  $0.025\mu\text{g}$ .

The results of GA, BA and kinetin over the same range of concentrations are rather variable. It cannot be categorically stated at this time that their combined presence in an extract would not seriously affect the results of a bioassay on ABA. For our bioassay it would be necessary to use extracts which have been purified as much as possible, for example by employing the techniques of Rudnicki (1969) for extracting ABA from apple seed. In contrast Davis *et al.* (1968) were able to use extracted hormones with a minimum of preliminary purification. It must be pointed out that the present bioassay cannot be used for identifying ABA. Its identity has to be established by other methods, such as those of Milborrow (1967) and Rudnicki (1969).

The slope of the regression line for the relationship between concentration of ABA ( $10^{-5}$ —10mg/l) and dry weight of *Spirodela* over a twelve day growth period is greater than that for the eight day growth period, indicating a potentially more sensitive detection of ABA in a bioassay taken over a twelve day growth period than over an eight day period. The goodness of fit of the eight day results, however, was better than that for the twelve day results, indicating that an eight day period gives more reliable results.

Although, as previously reported (Van Staden *et al.* 1969) six plants per treatment appear the optimum number to work with, the results with three plants still gave satisfactory results. This saving in number of plants is important when selection criteria such as those used for a bioassay are imposed.

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## EUPHORBIA SPECIES FROM THE FLORA ZAMBESIACA AREA: IX

L. C. Leach

### ABSTRACT

The taxonomic and nomenclatural position in respect of *Euphorbia angularis* K1. and *E. cooperi* N.E. Br. ex Berger is discussed, as well as their relationship with such species as *E. nyikae* Pax and *E. grandicornis* Goeb. ex N.E. Br.

An emended description of *E. angularis* is given; one new species from Moçambique, *E. halipedicola* and a new variety, *E. cooperi* var. *calidicola*, are described and *E. ussangensis* N.E. Br. is reduced to varietal status in *E. cooperi*.

*E. breviarticulata* Pax is reinstated as a species distinct from *E. grandicornis*, of which the new subsp. *sejuncta* is described, and some tentative suggestions made concerning the possible identities of some of the other related East African species.

A key is provided for the taxa dealt with, together with a map showing their distribution as presently known.

### UITTREKSEL

EUPHORBIA SOORTE VAN DIE FLORA ZAMBESIACA GEBIED: IX.—Die taksonomie en nomenklatuur van *Euphorbia angularis* K1. en *E. cooperi* N.E.Br. ex Berger word bespreek sowel as hulle verwantskap met soorte soos *E. nyikae* Pax en *E. grandicornis* Goeb. ex N.E.Br.

'n Verbeterde beskrywing van *E. angularis* word gegee; 'n nuwe soort uit Mosambiek, *E. halipedicola*, en 'n nuwe variëteit, *E. cooperi* var. *calidicola*, word beskryf en *E. ussangensis* N.E.Br. word as 'n variëteit van *E. cooperi* beskryf.

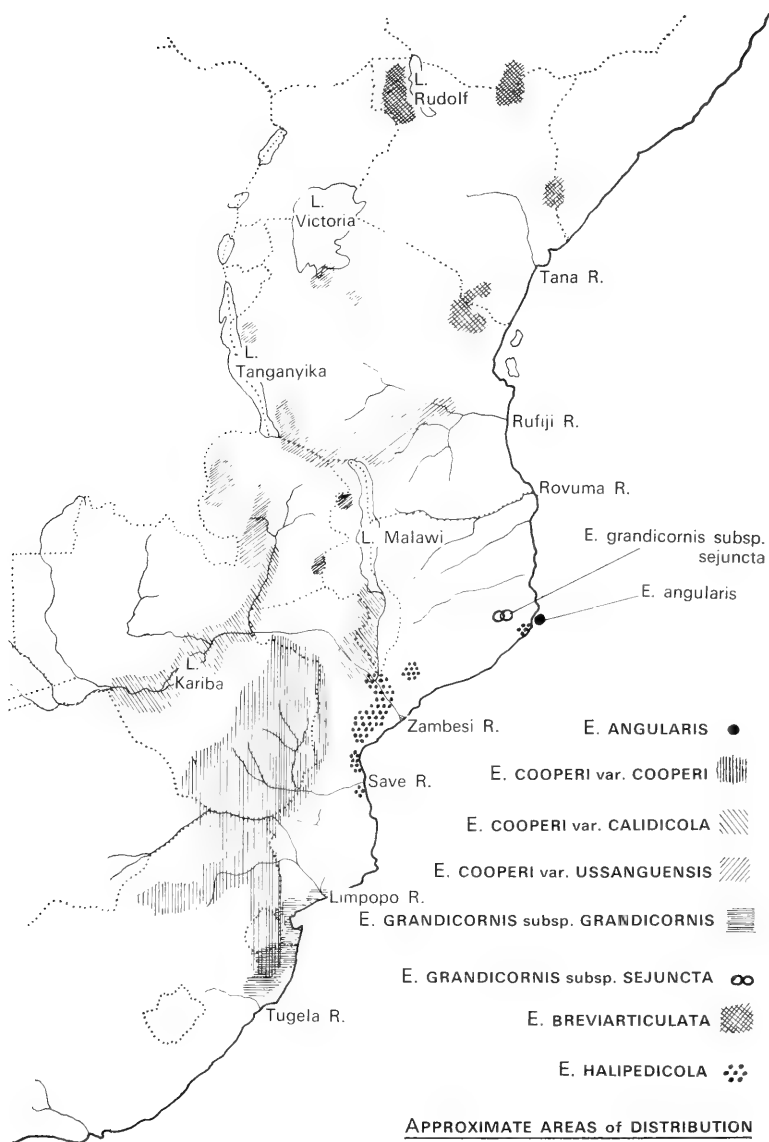
*E. breviarticulata* Pax word weer erken as 'n soort duidelik onderskeibaar van *E. grandicornis* waarvan 'n nuwe subsp. *sejuncta* beskryf word. Tentatiewe voorstelle oor die moontlike identiteit van sommige verwante Oos-Afrikaanse soorte word gemaak.

'n Sleutel vir die taksa bespreek word voorsien tesame met 'n kaart om hul bekende verspreiding aan te toon.

### INTRODUCTION

In this, the ninth in the series, the writer attempts to clarify the taxonomic nomenclatural position in respect of *Euphorbia angularis* Klotzsch and *E. cooperi* N.E. Brown ex Berger and their relationship with such species as *E. nyikae* Pax and *E. grandicornis* Goeb. ex N.E. Brown.

It was found that a large proportion of the type material of the species involved is, from one cause or another, non-existent, and that much of the herbarium material available is quite inadequate for any critical taxonomic study. Furthermore many of the original very brief descriptions, being not only vague and scarcely diagnostic but also often based on sterile specimens, are consequently of little assistance.



It therefore became apparent that any solution to the taxonomic problems involved must be sought in the field. Accordingly, as many as possible of the type localities (or regions), where these could be established, were visited. Herbarium specimens as well as live plants for further observation under cultivation were obtained from these and other localities, wherever members of the complex were found.

The conclusions drawn from a study of this material and of that already existing in various herbaria, as well as of the relevant literature are set out in the following notes.

Chronological list of the species discussed (nomenclatural synonymy excluded), with locality of original publication in respect of species for which this is not cited elsewhere.

- Euphorbia angularis* Klotzsch (1862)  
 „ *lemaireana* Boissier (1862)  
 „ *nyikae* Pax (1895)  
 „ *grandicornis* Goebel ex N.E. Brown (1897)  
 „ *bussei* Pax, in Engl. Bot. Jahrb. **33**: 286 (1903)  
 „ *breviarticulata* Pax (1904)  
 „ *mbaluensis* Pax, in Engl. Bot. Jahrb. **34**: 85 (1904)  
 „ *intercedens* Pax, in Engl. Bot. Jahrb. **34**: 75 (1904)  
 „ *cooperi* N.E. Brown ex Berger (1907)  
 „ *hubertii* Pax in Schles. Ges. Vaterl. Cult. **2**: 151 (1911).  
 „ *kibwezensis* N.E. Brown in Fl. Trop. Afr. **6**, 1: 586 (1912)  
 „ *ussanguensis* N.E. Brown (1912)

#### KEY TO THE SPECIES DEALT WITH

Shrubs without or with a very much reduced main trunk

Spines usually more than 2 cm long

Inflorescence with up to 6 or more cymes randomly arranged and the central male cyathium usually deciduous; segments generally  $\pm$  transversely oblong,  $\pm$  twice as broad as long.....(5) *E. breviarticulata*

Inflorescence with 1—3 cymes regularly transversely arranged, with the central male cyathium usually deciduous

Segments 3—4-winged, subcircular or subrectangular or  $\pm$  broadly ovate, generally  $\pm$  as long as broad.....(4a) *E. grandicornis* subsp. *grandicornis*

FIG. 1.

Some of the apparent distributional discontinuities shewn in the map are thought probably to be due to inaccessible and difficult terrain with the consequent lack of collecting

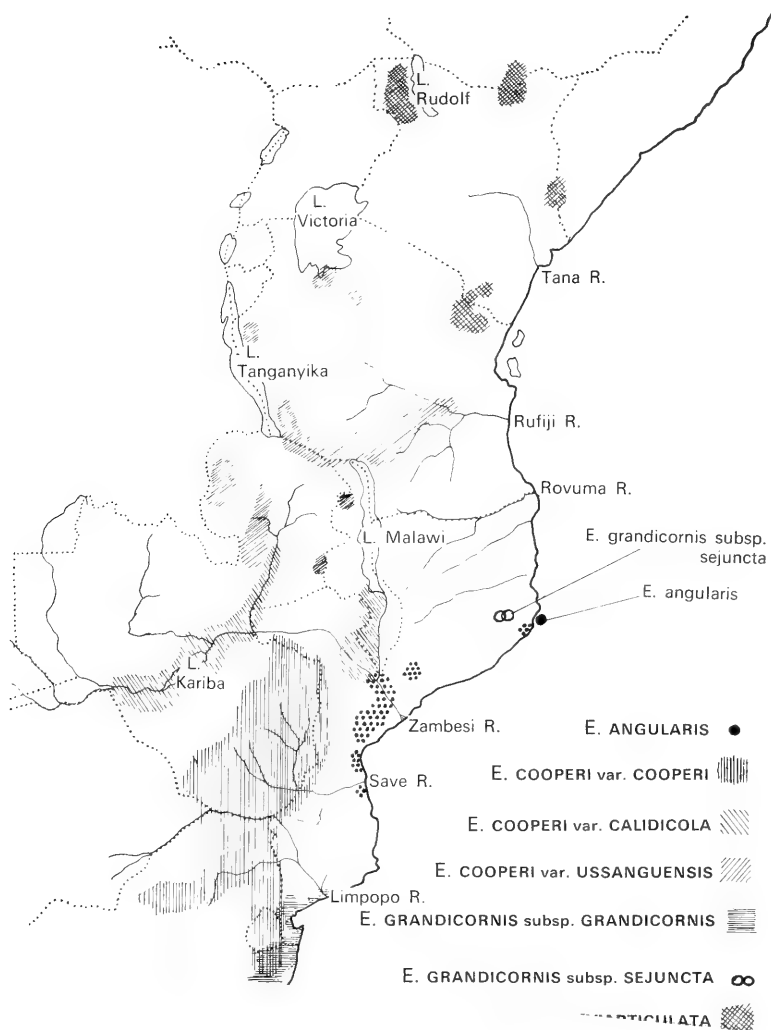
#### ERRATUM

Journal of South African Botany, Vol. 36 Part 1: 13-52 (1970).

“*Euphorbia* species from the Flora Zambesiaca Area IX”

In the key on page 15 the “Inflorescence” clue leading to *Euphorbia grandicornis* should read:

Inflorescence with 1-3 cymes regularly transversely arranged, with the central male cyathium usually *persistent*.



It therefore became apparent that any solution to the taxonomic problems involved must be sought in the field. Accordingly, as many as possible of the type localities (or regions), where these could be established, were visited. Herbarium specimens as well as live plants for further observation under cultivation were obtained from these and other localities, wherever members of the complex were found.

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 „ *ussanguensis* N.E. Brown (1912)

#### KEY TO THE SPECIES DEALT WITH

Shrubs without or with a very much reduced main trunk

Spines usually more than 2 cm long

Inflorescence with up to 6 or more cymes randomly arranged and the central male cyathium usually deciduous; segments generally  $\pm$  transversely oblong,  $\pm$  twice as broad as long.....(5) *E. breviarticulata*

Inflorescence with 1—3 cymes regularly transversely arranged, with the central male cyathium usually deciduous

Segments 3—4-winged, subcircular or subrectangular or  $\pm$  broadly ovate, generally  $\pm$  as long as broad.....(4a) *E. grandicornis* subsp. *grandicornis*

#### FIG. 1.

Some of the apparent distributional discontinuities shewn in the map are thought probably to be due to inaccessible and difficult terrain with the consequent lack of collecting, e.g. *E. cooperi* var. *calidicola* almost certainly occurs along the Zambesi between the Luangwa Riv. confluence and Tete, although there are no records. Similarly *E. halipedicola* is probably to be found on the coastal plain between the Zambesi and Lumbo. This latter species has also, in all probability, suffered from considerable habitat interference from “shifting agriculture” in that region.

- Segments 2—3-winged, variable in shape from subcircular to narrowly oblong  
 Spines usually less than 1.5 cm long ..... (4b) *E. grandicornis* subsp. *sejuncta*  
 Capsules relatively deeply lobed, 15—16 mm diam. .... (1) *E. angularis*  
 Shrubs or small trees with a stout central trunk  
 Inflorescence with up to 6 or more cymes randomly arranged, with the central male  
 cyathium usually deciduous; segments oblong,  $\pm$  twice as long as broad, or the  
 terminal segment  $\pm$  broadly ovate. .... (6) *E. halipedicola*  
 Inflorescence with 1—3 cymes regularly transversely arranged, with the central male  
 cyathium persistent  
 Capsule clearly exserted from the involucre on a slightly curved, sub-obconic  
 pedicel  
 Segments 4—6-winged,  $\pm$  conic-ovate, wings 5—6 mm thick .....  
 (3a) *E. cooperi* var. *cooperi*  
 Segments 3—4-winged, ovate to depressed ovate, wings  $\pm$  3 mm thick .....  
 (3c) *E. cooperi* var. *calidicola*  
 Capsule barely exserted from the involucre on a short straight pedicel; segments  
 very variable from subcircular to depressed obovate, 4—9-winged, wings  
 5—10 mm thick. .... (3b) *E. cooperi* var. *ussanguensis*

The main difficulty in constructing a workable key to the succulent members of the genus is the extent of the variation exhibited in their vegetative characters. When viewed in the field the distinctions may be clear enough, but it is often a very different matter to apply these to a single herbarium specimen (consisting sometimes of only a small portion of a wing), without recourse to the aid given



FIG. 2.

*E. cooperi* var. *cooperi* Leach 9458  
 shewing regular arrangement of 3 buds.

*E. breviarticulata* Leach & Bayliss  
 10241 shewing irregular arrange-  
 ment of six peduncle scars.

*E. sp.*, Dar-es-Salaam, Leach &  
 Brunton 10165 shewing exception-  
 ally large number of irregularly  
 arranged buds.

to identification by locality. Undesirable though this course may be, it seems to be unavoidable in many instances, especially when the material is sterile.

One of the most useful characters lies in the arrangement of the inflorescence but this is difficult, indeed sometimes impossible, to determine from dried material. Even in this character there are occasional aberrations, e.g. in some individuals of *E. cooperi* var. *cooperi* occurring in the Zoutpansberg District of the Transvaal there is a tendency for the cymes to proliferate, additional buds sometimes developing above and below the normal row of three; under these conditions crowding sometimes results in a somewhat random arrangement of the peduncles, reminiscent of, but never actually as irregular as in *E. halipedicola* and other East African species, in which, incidentally, the cymes, when 2—3, may sometimes be more or less in transverse alignment. However such abnormalities are usually such a small proportion of the whole, that it is considered that they are scarcely likely seriously to affect the working of the key.

#### EUPHORBIA ANGULARIS

*Euphorbia angularis* K1. being the oldest of the names presently under consideration, its relation to the taxonomy and nomenclature of the African succulent Euphorbias is such that it is thought necessary, at risk of some tediousness, to discuss in detail the more important points raised, both in literature and personal discussions, by other workers in this field, and their interpretations of Klotzsch's description.

It is not known whether this description was based on Peters's material or on a cultivated specimen (or possibly on a combination of these). That a plant was actually in cultivation at Berlin-Dahlem seems evident from Boissier's citation in DC. Prodr.: "Peters in h. Berol.!" whether this was an imported plant or one grown from a cutting is not known (that it was raised from seed appears to be most unlikely as no mention is made of either fruits or seeds).

(1) *Euphorbia angularis* Klotzsch in Peters, Reise Mossamb. Bot. 92 (1862).—Pax in Engl. Bot. Jahrb. 34: 76 (1904) pro parte.—N.E. Br. in Fl. Trop. Afr. 6, 1: 584 (1912) pro parte.—White, Dyer & Sloane, Succ. Euphorb. 2: 881 (1941) pro parte.—Jacobsen, Handb. Succ. Pl. 1: 406 (1960) pro parte.

Type: Moçambique, Moçambique Distr., Goa Island, 15° 03' S: 40° 27' E, Peters s.n. (B†); Neotype: Leach 12361 (K; LISC; MO; PRE; SRGH; ZSS).

*Euphorbia abyssinica* var. *mozambicensis* Boiss. in DC Prodr. 15, 2: 84 (1862).

Type as above.

*Euphorbia cactus* sensu Schweinfurth in Bull. Herb. Boiss. Sér. I, 7, App. 2: 321 (1899) pro parte.

Note: as *E. angularis* is known only from Goa Island, all the above "pro parte" references exclude everything except Peters's specimen from that locality and Boissier's synonym which is based on the same type.

*E. angularis* sensu Pax in Engl. Pflanzenw. Afr. (Engl. & Drude, Veg. der Erde) 9, 1: 443 et fig. 376 (1910), is *E. cooperi* N.E. Br. ex Berger, as is that of Eyles in Trans. Roy. Soc. S. Afr. 5: 398 (1916).

*E. angularis* sensu Hutch., Botanist S. Afr.: 488 (1949) is, almost certainly, *E. candela-brum* Trém. ex Kotschy.

MOÇAMBIQUE. N: Moçambique Distr., Goa Is., st. 19.v.1961, *Leach & Rutherford-Smith* 10932 (K; PRE; SRGH); fl. & fr. 10.viii.1964, *Leach* 12361 (K; LISC; MO; PRE; SRGH; ZSS).

The "Cereus-like habit" of Klotzsch's German text, which appears to have given rise to some misconceptions, seems also to be implicit in the "Sectio cereiformes" of the Latin, but may perhaps, be accounted for by his having drawn up his description from a rooted cutting. This could also explain the 3-angular unbranched stem; such plants, grown from cuttings from various species, do sometimes adopt a similar unnatural habit. In any event it is thought that not too much importance should be attached to "Cereus-like" as the same expression has been applied, equally inappropriately, to other species, e.g. Pax in writing "*Frutex ramosus, habitu Cerei* sp. *simulans*" when describing *E. robecchii*. However, the Latin description also states "*Fruticosa trunco cylindrico*", and this exactly describes the plants extant on Goa Island today, albeit the trunk is very short and gnarled. Elongated prostrate main branches sometimes adopt a terminally erect habit, in such instances the main branch is, amidst the tangled mass of branches, easily mistaken for a partly prostrate 3-angled trunk; mature plants on Goa Island are, incidentally, about "the height of a man" or less.

It has been suggested that Klotzsch may have been describing *E. ingens* E. Mey. ex Boiss. but, apart from the fact that this species does not occur on the island, this is thought to be highly improbable in view of the "decurent bosses" and "sessile inflorescence" of the description. Furthermore any 1.5—1.8 m high specimens of *E. ingens* known to the writer have been 4-angled and have not been known to flower until at a considerably greater age than would be indicated by this height.

Another suggestion is that Klotzsch's description indicates an interrupted margin to the wings or angles. Now although such an interpretation is possible there is nothing in either the German or Latin texts which would preclude the possibility of the margin's being continuous. N.E. Brown includes Kirk's Lower Zambesi plants (both with continuous margins) in his concept of *E. angularis* and places *E. lemaireana* (also with continuous margins) in synonymy; Pax included *Goetze* 1008 (later the type of the continuous margined *E. ussan-*



*guensis*) in *E. angularis*, and finally Schweinfurth, when writing up *E. cactus* Ehrenb. ex Boiss. placed *E. angularis* in synonymy. As these authors had all seen Peters's specimen it is thought that this can be accepted as conclusive evidence that its margins were, in fact, continuous.

The cyathium referred to appears to be very young, at which stage "stigmas erect, not exceeding the male flowers" would quite normally, in inflorescences of this group, correspond to "erect glands" and "rounded sessile ovary" (N.E. Brown and White, Dyer & Sloane both describe the capsule but this appears to refer to Kirk's material from the mainland), the ovary of *E. angularis* is, moreover, quite globose until a relatively late stage in its development.

Klotzsch's own suggestion that his species might not belong in *Euphorbia* appears to stem from his misinterpretation of the male flowers (which are, in fact, quite normal for the genus) and the sessile ovary (which is also quite normal in immature cyathia, even in many species in which the capsule is ultimately far exserted). Furthermore when live plants and fresh material are examined then Klotzsch's description becomes more intelligible and there is certainly nothing contained therein which could be considered to exclude the Goa Island population.

It is felt therefore, that on the available evidence, there is no reason to doubt that the identity of *E. angularis* is that of the plants existing today on Goa Island. This is a tiny coral islet (uninhabited other than by the lighthouse keeper and his assistants) lying at the entrance to Mossuril Bay on the N. Moçambique coast, on which the dominant vegetative feature is a succulent shrubby *Euphorbia*, namely, *E. angularis*. There are probably some hundreds of plants, some of which appear to be quite old (judging by the rate of growth of plants in cultivation) and there seems no reason to suspect that the population is materially different from that seen by Peters more than a century ago.

Morphologically *E. angularis* appears to be most closely related to *E. cooperi* complex and, to a lesser extent, to *E. grandicornis* and related plants of the Moçambique coastal plain. Its closest affinity appears to be with *E. cooperi* var. *calidicola* from which however, it differs in numerous characters, of which the more important are its entirely different habit; its larger involucre with larger, differently shaped glands, more coarsely fimbriate lobes and fewer male flowers, its larger more deeply lobed capsule which is subglobose when partially developed (that of its relative being trigonous at a similar stage of development) and is supported on a more or less cylindric pedicel which is quite different from the subobconic one of *E. cooperi* var. *calidicola*, while the styles are stouter and much enlarged at the apex as compared with those of its nearest relative; finally the seeds of *E. angularis* are larger and differently marked and the seedlings and juveniles of the two taxa are quite distinct.

Although the less closely related *E. grandicornis* is also of shrubby habit, *E.*



Mr. R. Rutherford-Smith examining a large plant at the type locality, Goa Island, Moçambique.



Cultivated plant showing reduced trunk and early stage of elongated main branches.

FIG. 3. *Euphorbia angularis*

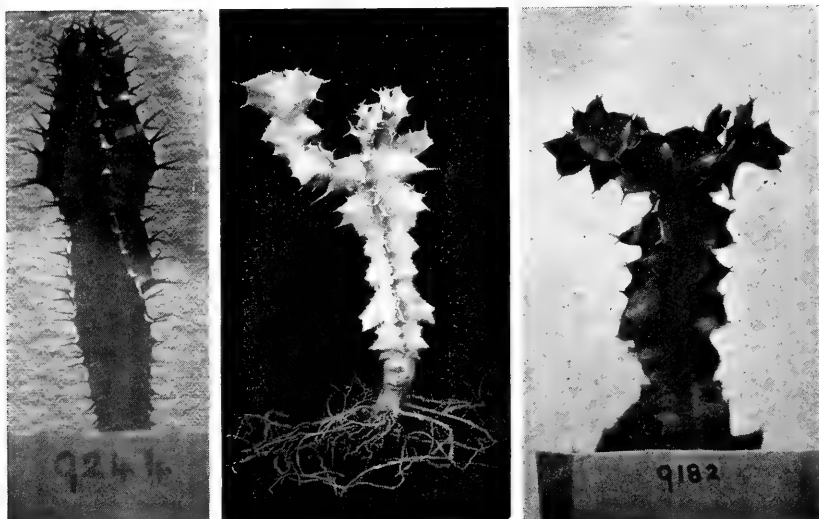


FIG. 4. Seedlings.

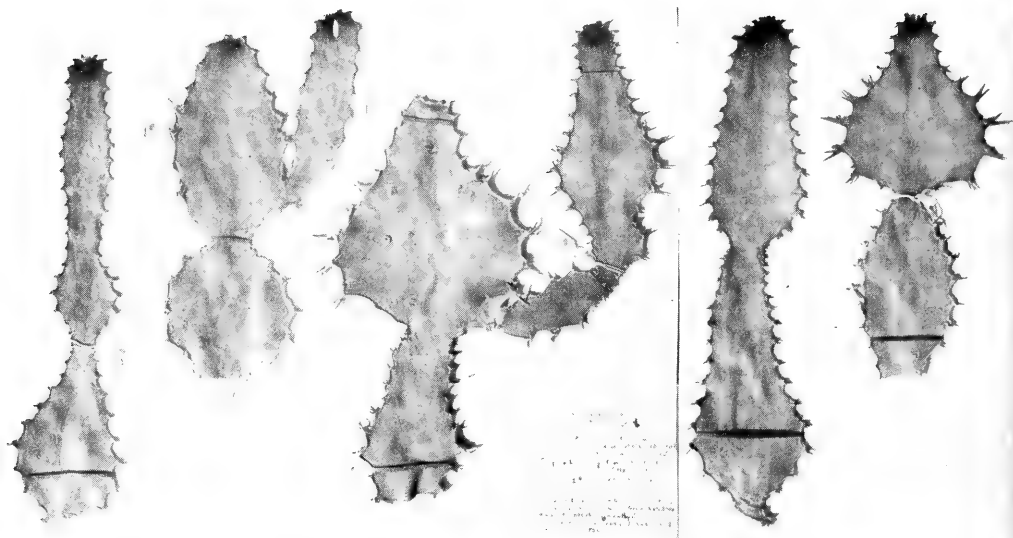
a. *E. cooperi* var. *cooperi*  
Leach 9244, Mtoko.

b. *E. cooperi* var. *calidicola*  
Leach 11611, Wankie.

c. *E. halipedicola* Leach 9182  
Manica e Sofala.

*angularis* may be easily distinguished by its more variable and differently shaped, more stoutly winged segments with their less fiercely armed and less flexuously undulate margins; while in the characters of its more compound inflorescence the larger cyathia and larger differently shaped fruits are most noticeable.

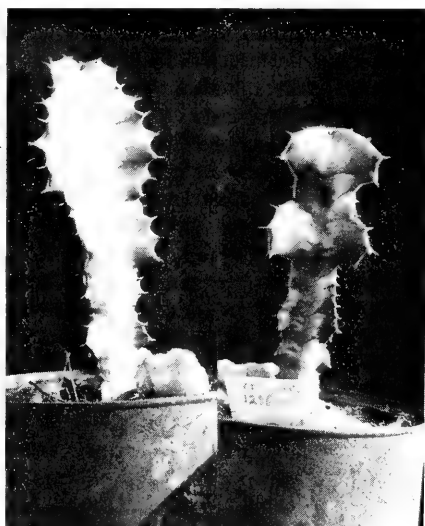
In spinescence Klotzsch's species most closely approaches *E. halipedicola* (newly described elsewhere in this paper) and it was probably this similarity which led N.E. Brown to include Kirk's two specimens from the lower Zambesi in his concept of *E. angularis* when comparing "the fragment in the Berlin Museum". However, in almost all other respects the two species are entirely different; particularly is this so in the arrangement of the inflorescence, which in *E. halipedicola* comprises a number (1—6) of randomly arranged, once forked cymes with relatively stalk-like peduncles and cyme branches and a deciduous initial cyathium, as opposed to the (1—3) regularly horizontally arranged, often several times forked cymes of *E. angularis*, with stump-like peduncles and cyme branches and a persistent initial male cyathium. In addition the two species may immediately be distinguished by the widely differing characteristics of their respective seedlings and the generally much longer, oblong segments of *E. halipedicola* as well as its stout trunk and taller stature.



Variation in segment shapes *Leach & Rutherford-Smith 10932 (SRGH)*.



Typical young plant, estimated 15 years old.  
The trunk has not grown beyond this point.



Typical seedlings,  $\pm$  4 years old.

FIG. 5. *Euphorbia angularis*.

*Plant*: a densely branched and rebranched, glabrous, spreading shrub, often with a diameter 2—3 times its height, up to  $\pm 2$  m high, with a much reduced trunk. *Trunk* initially 3-angled, soon becoming 4-angled subcylindric, usually much gnarled and distorted. *Branches* spreading, often decumbent with the apical portion ascending; much branched and rebranched, with the secondary branches and branchlets arising from the margins, usually towards the base of the segments; 3—4, usually 3-angled or winged (branchlets 3-angled), sometimes scarcely winged, then with the faces flat or only slightly concave, constricted into segments of varying shape and size with a stout solid central core which is more or less angular in cross-section. *Segments* oblong, elliptic, ovate or sometimes more or less circular, generally  $\pm 10$ —15 cm long  $\times$  7—12 cm broad; the more or less even or sinuate-toothed angles are provided with a continuous, horny, brown (becoming whitish grey) margin, usually  $\pm 2.5$  mm broad, widening up to 5 mm at the flowering eye and slightly less at the spine pairs. *Spines* in spreading, diverging pairs, longest at the widest part of the segments, up to  $\pm 10$  mm long, becoming much reduced towards the constrictions, generally c 10—25 mm apart along the angles. *Leaves* recurved, broadly ovate, acute, truncate at the base, c 1.5 mm long, soon deciduous, leaving a rather inconspicuous, transverse, narrowly reniform or depressed obovate scar with a pair of prickles (usually hooked) on either side. *Inflorescence* cymose, glabrous; cymes 1—3, horizontally arranged, each with 3 cyathia, often with secondary and tertiary branching and a correspondingly larger number of cyathia; flowering eye situated close to the lower of adjacent spine pairs or up to one third the distance between them above the lower pair, usually armed with a pair of straight or hooked spines, 1—3 mm long (occasionally with one or more additional small spines), often with several prickles. *Peduncle* bibracteate, very short and stout, 1—3 mm long  $\times$  c 5—6 mm in its greater diam.; bracts usually split and deteriorated, c 8 mm broad  $\times$  3 mm long. *Cymes* with the three cyathia arranged in a plane parallel with the axis of the branch; the initial central cyathium male, persistent; the primary and subsequent lateral cyathia are borne on cyme branches similar to but usually somewhat longer than the associated peduncle; frequently with secondary and tertiary laterals; some cyathia of such compound cymes abort while others appear to delay their development so that it is possible to find cyathia at various stages of development, even to the extent of ripe fruits and buds occupying the same cyme branch. *Bracts* more or less semi-circular or somewhat lunate, c 8 mm wide  $\times$  3 mm long, with a minutely denticulate margin, often split as subsequent laterals develop. *Involucre* glabrous, cup-shaped, c 9 mm diam.  $\times$  4 mm long; glands 5, spreading, entire, more or less transversely elliptic, slightly shallowly concave, minutely tuberculate-rugulose, sometimes with a slightly raised smooth outer margin, yellow, 4.5—7 mm  $\times$  2.25—3 mm; lobes fimbriate toothed, subquadrate: 1.75—2 mm wide;

fimbria relatively rather coarse ( $\pm 12$ ). *Male flowers* 35—50, with numerous filiform-fimbriate bracteoles, arranged in 5 bracteate fascicles; bracts deeply lacerate fimbriate; *pedicels* up to 4.5 mm long; *filaments* c 1.75 mm long. *Ovary* somewhat obovoid, seated on a rudimentary  $\pm$  pentagonal perianth; ovule suspended under a relatively long, somewhat 2-lobed fleshy obturator; partially developed capsule 3-lobed, subglobose with rather prominent obtuse ribs down the angles of the lobes, partially exserted from the involucre. *Styles* stout, 3.5—5 mm long, free almost to the base or united into a column for up to two thirds their length, the free portions spreading recurved, somewhat flattened, c 0.6 mm wide, deeply grooved down the inner face with enlarged, shortly bifid rugulose apices. *Capsule* deeply three-lobed, 14—17.5 diam. (generally 15—16)  $\times \pm$  8 mm high, truncate at both apex and base, shortly exserted from the involucre on a slightly curved, obscurely pentagonal towards the base, stout pedicel up to 7 mm long  $\times$  c 3 mm diam., merging into the perianth; perianth c 6 mm diam. more or less triangular with small intermediate teeth closely adpressed to the capsule in the sinuses of the lobes. *Seed* subglobose, slightly laterally compressed, c 3.5 mm in its greatest diam., smooth

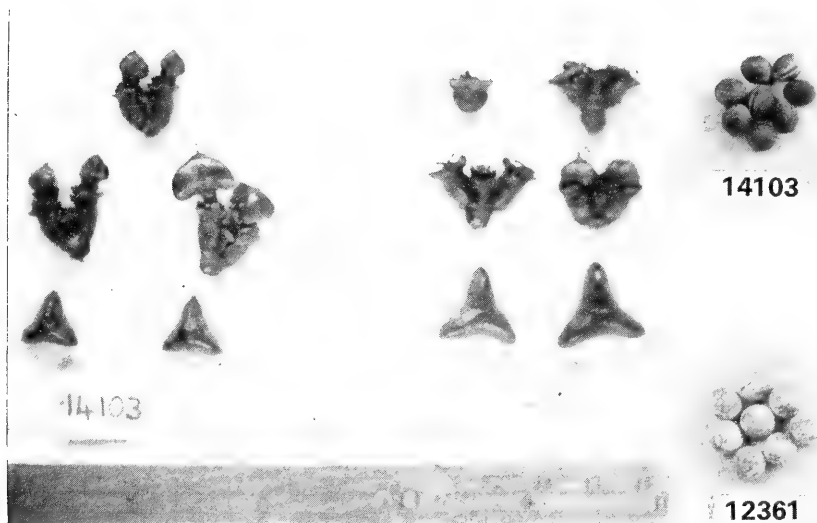


FIG. 6. A comparison: 14103 *E. cooperi* var. *calidicola*

12361 *E. angularis*

Note the more deeply-lobed, larger capsules of *E. angularis*, which are also much more subglobose at an earlier stage.

or very slightly and obscurely pusticulate, buff, pale purple clouded, minutely punctulate with blackish purple; suture slightly raised, obtuse, brown.

From the present records it seems that *E. angularis* is restricted to Goa Island, although those authors who have considered *E. lemaireana* as being synonymous have included Zanzibar in its distribution.

Only one specimen from that island has been seen by the writer, namely, *Greenway* 1188 (EA). Although this was collected from a habitat apparently rather similar to that occupied by *E. angularis* and exhibits some of the characters of that species it is difficult to form a definite opinion without seeing material which is more complete. In some ways it is thought to be more probable that the affinities of this specimen lie with the polymorphic populations of the adjacent mainland littoral which require much more investigation before any taxonomic conclusions can be reached.

#### EUPHORBIA LEMAIREANA

The identity of *E. angularis* seems to have posed a problem to taxonomists almost from its publication; one of the names most frequently tentatively placed in synonymy by various authors is that of *E. lemaireana*. It is thought to be of interest therefore to discuss this latter species in some detail.

(2) ***Euphorbia lemaireana*** Boiss. in DC. Prodr. **15**, 2: 81 (1862).—Pax in Engl. Pflanzenw. Ost-Afr. "C": 241 (1895) et in Engl. Bot. Jahrb. **34**: 73 (1904).—Janse in Sukkulantenkunde **3**: 58 (1949).—Type: A living plant cult. Paris; ? ex Zanzibar, comm. *A. Richard* (c 1853).

*Euphorbia fimbriata* Hort. ex Lem. in Ill. Hort. Misc.: 71 (1857), non Scop. (1788).—Type as above.

*Euphorbia crispata* Lem. loc. cit. (1857) non Hornemann (1819).—Type as above.

*Euphorbia grandicornis* sensu Berger, Sukk. Euphorb.: 52 (1907) pro parte quoad syn.

*Euphorbia angularis* sensu N.E. Brown in Fl. Trop. Afr. **6**, 1: 585 (1912) pro parte quoad syn.—sensu White, Dyer & Sloane, Succ. Euphorb. **2**: 881 (1941) pro parte quoad ?syn.—Jacob. Handb. Succ. Pl. **1**: 446 (1960) pro parte quoad ?syn.

Boissier's description was based on a live but sterile plant cultivated in the garden of the Paris Museum; it seems that this plant eventually died without having flowered (at least there appears to be no record of such an event). Whether the various plants in cultivation, photographs of which have been

published above the name *E. lemaireana*, were actually propagated from cuttings from the Paris plant seems open to some doubt.

Boissier, who appears to have seen the live plants of both *E. angularis* and *E. lemaireana*, considered them to be distinct, and on the score of habit alone it seems scarcely possible for *E. lemaireana* (ht. 4·5 m) to have been taxonomically identical with either *E. angularis* or *E. grandicornis*, both of which are densely branched shrubs, usually less than 2 m high.

Berger, who did not mention *E. angularis* in his monograph of 1907, considered *E. lemaireana* and *E. grandicornis* possibly to be synonymous, but apart from stature the 20 cm long segments of *E. lemaireana* would appear to rule out this possibility.

The description by Boissier of a shrub with few decumbent curved branches and segments up to 20 cm long, with undulate margins and much compressed wings seems rather to point to an affinity with plants of the East African littoral and his reference to the central cylindric part of the segments would seem to be almost certain confirmation of this relationship while almost equally definitely excluding it from *E. angularis* or *E. cooperi* complex.

There are numerous populations, corresponding closely to this description, to be found along the east coast of Africa today and it seems probable that Boissier's species may be equal to one or other of these. However, in the absence of material or of any description of the inflorescence or fruits, it is felt that there is little, if any possibility of positively establishing its identity. As far as is known to the writer the name is not currently in use for any wild plants and even the Zanzibar locality seems to contain a slight element of doubt; it therefore seems pointless to speculate further on its identity, and it should in the writer's opinion, be considered as a *species non satis cognita*.

#### EUPHORBIA COOPERI COMPLEX

Chronologically the next name involved is that of *E. nyikae* Pax which, considered to belong, together with other related species, to the East African grouping, is discussed in greater detail elsewhere in this paper. It suffices here to note that it is excluded from *E. cooperi* by its Phyllocacti-like, sometimes 2-winged branches and small, usually separate spine shields, as well as, it seems probable, some details of the inflorescence.

Illustrative of the uncertainties which appear to have surrounded *E. cooperi* complex since the original importation of living plants as far back as 1860, is the history of the specimen Goetze 1008. Identified by Pax in 1901 as *E. nyikae* it was transferred by him in 1904 to *E. angularis* and again transferred in 1912 to become the type of N.E. Brown's *E. ussanguensis* which is now reduced to varietal rank in *E. cooperi*.



(3) ***Euphorbia cooperi*** [N.E. Br. in Handl. Dicot. Kew: 295 (1900), nom. nud.] N.E. Br. ex Berger, Sukk. Euphorb.: 83 (1907), excl. fig. 21.—N.E. Br. in Fl. Cap. **5**,2: 386 (1915).—Pole Evans in S. Afr. Journ. Sci. **17**,1: t.7 (1920).—Phillips in Flow. Pl. S. Afr. **4**: t.157 (1924).—Lotsy in Genetica **10**: 104 (1928).—Burt Davy, Fl. Transv. **2**: 296 (1932).—Bremek. in Karsten & Walter, Veg.-bild. 23: tt. 15 & 16a (1932).—Oberm. Schweick. & Verdoorn in Bothalia **3**: 242 (1937).—White, Dyer & Sloane, Succ. Euphorb. **2**: 873 (1941).—Codd, Trees shrubs Kruger Nat. Park: 96 (1951).—Wild, S. Rhod. Dict. Pl. Names: 83 (1952).—Pardy in Rhod. Agr. Journ. **52**,5: 416 (1955).—Jacob. Handb. Succ. Pl. **1**: 422 et fig. 486 (1960).—B. & M. de Winter & Killick, Sixtysix Trees Transv.: 100 (1966).—Compton, Check List Fl. Swazil.: 53, 126 (1966).

Type: Hort. La Mortola, *Cooper*, Natal, Umgeni Valley. Neotype: idem Hort Reg. Kew. (K!).

*Euphorbia angularis* sensu Engler in Engl. Pflanzenw. Afr. (Engl. & Drude, Veg. der Erde) **9**,1: 443 et fig. 376 (1910).—sensu Eyles in Trans. Roy. Soc. S. Afr. **5**: 398 (1916).—sensu White, Dyer & Sloane, tom. cit. quad fig. 1004 (1941).

*Euphorbia grandidens* sensu Burt Davy in Transv. Agr. Journ. **4**: t.38 (1905).—sensu Eyles, tom. cit.: 399 (1916).

Note: *E. cooperi* sensu Hutch. Botanist S. Afr.: 320/21 (1949) is, in fact, *E. confinalis* R.A. Dyer, and that of Cannon in Carnegie Inst. Wash. Publ. 354: t. 5c (1924) is *E. ingens* E. Mey. ex Boiss.

*E. cooperi* sens. lat. appears to vary more or less on the pattern of a discontinuous altitudinal cline, with a marked tendency for a reduction in altitude to be correlated with fewer thinner wings to the branches, longer spines, and more numerous male flowers. Although correlation of these variations with altitude is by no means absolute, the species does seem to fall into three, generally recognisable, altitudinally separated main groups which seem to demand some taxonomic recognition.

In choosing varietal rather than subspecific status for these the author has been influenced by the fact that despite the generally quite well defined populations there are individuals from lower hotter parts of the distributions of both var. *cooperi* and var. *ussanguensis* which can, other than on the basis of locality, and only with uncertainty, be distinguished from each other and from some examples of var. *calidicola* (such examples are, incidentally, mostly quite widely geographically separated). Furthermore, some of the distinctions appear to be largely, if not entirely, governed by climatic and/or edaphic factors, since juveniles of all three varieties, readily distinguishable when collected, have, after some 8—9 years in cultivation, come more closely to

resemble each other in one or two of their vegetative characters, particularly in shape of segments.

Individual variability is such that it may often be virtually impossible to identify some herbarium specimens at varietal level except from their locality, especially as some characters inevitably become lost or obscured in the preparation of this most difficult to handle material.

Common to all three taxa is the exceptional acidity of the latex; one's lips and nostrils are almost always affected after gathering or preparing material.

Populations in which all or almost all the individuals adopt a shrub-like habit as opposed to the more usual tree-like habit, so typical of most plants of var. *cooperi*, are occasionally encountered in all three varieties. The overall appearance of these colonies is sometimes so distinctive that one is liable to gain the impression that distinct taxa may be involved, but on investigation there seems to be no doubt that these are but localised forms of one variable species.

### (3a) Var. *cooperi*

The typical variety is characterised by its generally 4—6-angled branches with more or less conic-ovate segments and relatively stout wings with continuous, more or less even or slightly sinuate-toothed, horny margins which are generally about 5—6 mm wide and armed with relatively short, stout, widely diverging paired spines, usually less than 10 mm long; the capsule is shortly exerted from the involucre on a stout, more or less truncate obconic, slightly curved pedicel. Seedlings of this variety are relatively stout, usually soon developing 4—6 angles, generally scarcely winged, green or dark green, often marbled.

Its distribution extends from Natal, more or less throughout Swaziland, the Transvaal and Rhodesia with some slight extensions into the western regions of southern Moçambique, generally at altitudes of  $\pm$  1000 ft.—4500 ft. (rather rarely below  $\pm$  1500 ft.).

Judging by N.E. Brown's notes on the type sheet of *E. cooperi* there seems to be no doubt that Cooper's plant was discovered in the Umgeni Valley, where he is stated to have seen "only a few plants". Unfortunately however, Cooper's locality has not been rediscovered, the most southerly subsequent record being from the Umhlatusi Valley (c 28° 45' S), *J.S. Lawn* 527 (NH), (personal comm. Mr. C. J. Ward, University College, Durban).

The history of this variety, at least as applicable to the S. African portion of its distribution, has been dealt with in detail by White, Dyer & Sloane in their monograph of 1941 and will not, therefore, again be discussed here.

FIG. 7. *Euphorbia cooperi* var. *cooperi*.

Leach 11635, Nelspruit.

Leach 9244, Mtoko.

Plants, mostly less than 20 ft. high, generally form discrete, usually densely populated colonies, often on hillsides, where they then become a conspicuous component of the vegetation.

The flowering period appears to be exceptionally long, as may be judged from the records, e.g. complete flowering material was collected from a plant growing near Moodie's Pass in the Bikita District of Rhodesia on 22.v.1959 and the same individual was still bearing unripe capsules and some less developed cyathia on the 27th of August in the same year.

Individuals at some of the Rhodesian and Moçambique low altitude localities, conforming to the overall variation trend of the altitudinal cline, often display a proportion of 3-winged branches, but it is rarely that such branches predominate.

The styles may vary in length from  $\pm 2$  mm, free almost to the base, to  $\pm 5.5$  mm, united for two-thirds their length; variations encompassing almost the whole of this range sometimes occurring in a single individual.

Capsules are normally more or less triangular or only slightly lobed when seen from above, and are generally  $\pm 10$  mm broad  $\times 6$  mm high, but individuals occur in which fruits may be up to  $13.5 \times 7.5$  mm while more rarely, plants bearing relatively deeply lobed capsules may be found.

Although these variations appear to be identified with individuals there does not seem to be any other correlated factor or character variation.

RHODESIA. N. Mrewa Distr.: Mazoe Riv., Maramba Res., 2700 ft., fl. 7.viii.1959, *Leach* 9264 (EA; K; PRE; SRGH); Maramba Miss., fr. 7.viii.1959, *Leach* 9270 (K; PRE; SRGH; ZSS). Mtoko Distr.: *Christian* 377 (PRE); 2 mls N of Mtoko, 3700 ft., fl. 24.vii.1959, *Leach* 9244 (BR; K; PRE; SRGH);  $\pm$  20 mls. SW of Mtoko, fl. 23.vii.1959, *Leach* 9238 (K; PRE; SRGH; ZSS).

W. Matobo Distr.: S. Matopos, fl. & fr. Oct. 1963, *Bullock* in *Leach* 11706 (EA; K; SRGH); Diana's Pool, fr. 12.ix.1955, *Plowes* 1875 (SRGH); Matopos, fl. 19.vi.1955, *Plowes* 1860 (PRE; SRGH); Matopos, fr. Aug. 1955, *Miller* 2957 (BUL).

C. Hartley Distr.: Battlefields, 3600 ft., fl. 31.viii.1956, *Whellan* 1121 (SRGH). E. Chipinga Distr.:  $\pm$  12 mls. N of Rupisi Hot Springs, fl. & fr. 11.x.1959, *Leach* 9458 (PRE; SRGH); *ibid.* fl. & fr. 25.ix.1965, *Leach & Müller* 13137. (K; LISC; PRE; SRGH; ZSS); Umtali Distr.:  $\pm$  21 mls. N of Umtali, fl. & fr. 19.vii.1964, *Leach & Chase* 12308 (K; LISC; PRE).

S. Gwanda Distr.: Marangudzi, 2300 ft., fl. 10.v.1958, *Drummond* 5756 (LISC; PRE; SRGH); Shashi/Simplala Riv. Junct., fl. 8.v.1959, *Drummond* 6113 (PRE; SRGH); Sentinel Ranch, st. 24.iii.1959, *Drummond* 5981 (SRGH);  $\pm$  12 mls. N of West Nicholson, fl. 2.viii.1930, *Gillett* 3857 (BOL; PRE). Chibi Distr.: Lundi Riv. Br., fl. 6.v.1963; *idem*, fr. 11.viii.1963, *Leach* 11647 (K. LISC; M; MO; PRE; SRGH; ZSS). Victoria Distr.: Zimbabwe, fl. 14.viii.1937, *Mogg* s.n. (PRE). Bikita Distr.:  $\pm$  10 mls. W of Moodies Pass, 3500 ft., fl. 24.v.1959, *Leach* 9017 (PRE; SRGH); *idem*, fr. 27.viii.1959, *Leach* 9321 (K; PRE; SRGH); Devuli Riv., *Noel* s.n. (SRGH); near Birchenough Br., *Stock* s.n. (PRE; SRGH), Ndanga Distr.: Sabi/Lundi Riv. Junct., 800 ft., fl. 5.vi.1950, *Wild* 3398 (PRE; SRGH), *Hall* 100, 11.vi.1950 (NBG). Nuanetsi Distr.: NW Mateke Hills, 2400 ft., 4.v.1958, *Drummond* 5554 (PRE; SRGH).

TRANVAAL: 2229 (Waterpoort): near Ingwe Motel, Zoutpansberg (-DD), fl. 29.v.1963, *Leach* 11680 (FHO; M; MO; PRE; SRGH); Zoutpan (-D), fl. 15.iv.1934, *Schweickerdt & Verdoorn* 649 (PRE); Waterpoort (-D), st. 23.i.1959, *Werdermann & Oberdieck* 1996 (PRE).

2230 (Messina): 6 mls. NW of Punda Maria (-D), 18.v.1949, *Codd & De Winter* 5563 (PRE).

2231 (Pafuri): near Makulek, S of Levubu Riv., fr. Aug. 1937, *Van der Merwe* 1451 (PRE).

2329 (Pietersburg):  $\pm$  30 mls. N of Pietersburg (-BC), fr. 6.ix.1963, *Leach* 11714 (PRE);  $\pm$  18 mls. E of Pietersburg (-DD), fl. 3.viii.1961, *Van Vuuren* 1216 (PRE).

2429 (Zebediela): "near a kaffir village, Potgietersrust Distr." *Marloth 5143* (K; PRE); "Zebedela's location", hort. *Marloth 7996* (PRE); Botsebelo Mission, Little Oliphants Riv., fl. & fr. July 1923, *Anon* in *Marloth 11759* (PRE).

2430 (Pilgrims Rest): Penge Mine, Lydenburg Distr., (-AD), fl. 12.vii.1936, *Van der Merwe 1004* (PRE); Haakdoordraai (-BD), fr. 15.v.1965, *Leach & Jones 12822* (PRE); Driekop, Sekukuniland (-CA), fl. & fr. 21.iv.1935, *Barnard 25* (PRE); Sekukuniland, fr. 3.xi.1935, *Barnard 433* (PRE):

2527 (Rustenburg): 3 mls. W of Rustenburg (-CA), *Phillips & Schweickerdt* (PRE); Buffelspoort Farm, near Sterkstroom (-DA), *Burt Davy 5993* (PRE); Brits (-D), fl. 31.v.1935, *Dyer 3183* (PRE); fl. ♂, 22.iii.1935, *Mogg s.n.* (PRE); fl. 2.v.1958, *Van Vuuren 536* (PRE). 2529 (Witbank), Trichardt's Poort, ± 55 mls. from Pretoria, fl. 27.vi.1935, *Dyer 3189* (PRE). 2530 (Lydenburg), 3 mls. S of Nelspruit (-DB), fl. 28.iv.1963, *Leach 11635* (K; PRE; SRGH).

2531 (Komatipoort): Komatipoort (-BD), *Rogers s.n. 2504* in Herb. Transv. Mus. (K; PRE); Kaapmuiden (-B), fl. July 1936, *Van der Merwe E16* (PRE).

SWAZILAND. 2631 (Mbabane): Forbes Drift, Komati Riv. (-AA), cult. Manzini, fr. 20.viii.1963, *Stark* in *Leach 11715* (PRE; SRGH).

NATAL. 2731 (Louwsburg): 7 mls. S of Mkusi on Nongoma Rd. (-DB), fl. 11.iii.1964, *Edwards 3289* (PRE); 4—5 mls. N of Magut (-B), *Dyer 3476* (PRE).

MOÇAMBIQUE. **LM.** Namaacha, fl. 2.v.1964, *Balsinhas 717* (LISC); *ibid.* fr. 25.viii.1967, *Gomes e Sousa & Balsinhas 4952* (LMA; PRE).

**T.** Tete Distr., Mazoe Riv. 6 mls. from Rhodesian border, *Wild 2603* (SRGH).

**SS.** Sul do Save Distr., Dumela, fl. 11.vii.1964, *Leach H.H. & D.C. Mockford 12300* (BM; BR; EA; G; K; LISC; MO; PRE; SRGH).

(3b) **Var. *ussanguensis*** (N.E. Br.) Leach, stat. nov.

*Euphorbia ussanguensis* N.E. Br. in Fl. Trop. Afr. **6**, 1: 587 (1912).—Brenan & Greenway, T.T. Check List **2**: 214 (1949).—Type: Tanzania, Ussangu, *Goetze 1008* (B† K!).

*Euphorbia nyikae* sensu Pax in Engl. Bot. Jahrb. **30**: 342 (1901).—sensu Goetze & Engl., Veget. Deutsch Ost-Afr.: t.58 (1902).

*Euphorbia angularis* sensu Pax in Engl. Bot. Jahrb. **34**: 76 (1904) pro parte quoque syn. *E. nyikae* et specim. *Goetze 1008*.

*Euphorbia strangulata* sensu Hutch. Botanist S. Afr.: 532 (1949).

Basionym: *Euphorbia ussanguensis* N.E. Br.

TANZANIA. ± 5 mls. N of Zambian border on Sumbawanga road, c 5700 ft. alt., fl. 16.vi.1960, *Leach & Brunton 10053* (PRE; SRGH); near Sopa Barrier, fl. 16.vi.1960, *Leach & Brunton 10054* (K; LISC; SRGH); ± 26 mls. E of

Mbeya, 4100 ft. alt., fl. 25.vi.1960, *Leach & Brunton* 10105 (SRGH); Kalenga,  $\pm$  20 mls. WNW of Iringa, fl. 25.vi.1960, *Leach & Brunton* 10124 (B; SRGH); Kitonga Escarp. E of Iringa, 4300 ft. alt., fl. 26.vi.1960, *Leach & Brunton* 10125 (BR; EA; K; PRE; SRGH); "20 mls. N of Toroto Range", *Pole Evans & Erens* 766 (PRE).

Note: *Greenway & Kanuri* 13532, from SW side of Ngorongoro Crater appears to belong here, but identification is not certain as it is difficult to be sure of the arrangement of the inflorescence and the capsule is somewhat larger than usual for this taxon. (I have, unfortunately, not seen the spirit material).

There are other specimens which are either sterile or for some other reason not certainly identifiable which also probably belong here, e.g. *Verdcourt* 2885 (PRE), from Mwanza at the southern end of Lake Victoria; however, the long, narrow tapering segments and 4-angled section of this specimen, considered in conjunction with the locality, seem to indicate *E. hubertii* Pax as being likely to be its correct identification, as it possibly is also for *Verdcourt* 3434 (PRE), from a rock outcrop near Kigoma and *Greenway* 10741 (PRE) from Campi ya Mawi.

*E. hubertii* is, however, an imperfectly known species and further investigation is required before any decision can be reached regarding its status. Superficially there certainly seems no reason why these specimens as well as the photograph of plants on an island in Lake Victoria (?Winkler 4114a) in Winkler, *Das Leben der Pflanze*, 3: 484 (1913), should not belong in *E. cooperi* complex.

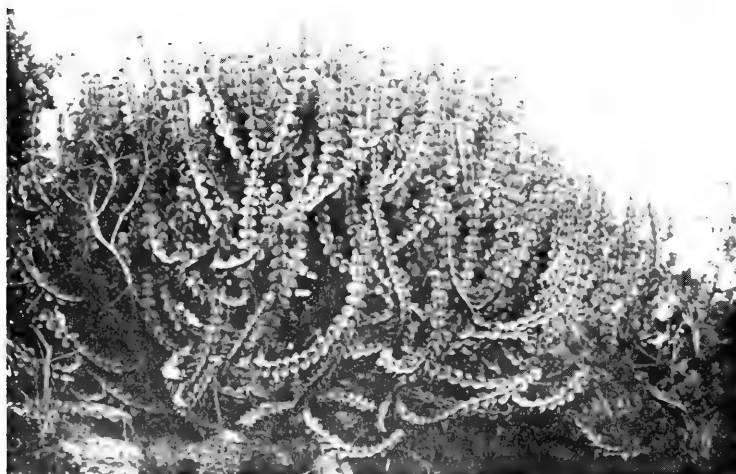
ZAMBIA. N. Mansa (Fort Rosebery): bud, 11.v.1964, *Fanshawe* 8621 (NDO; SRGH); Mpika, fl. 13.viii.1965, *Fanshawe* 9281 (SRGH); Kawambwa, young fr. *Fanshawe* 3870 (NDO), Ntumbachushi Falls, st. *Williamson* 1351 (SRGH); ?Sunzu "Sungu", fl. 25.vi.1955, *Lawton* 212 (NDO);  $\pm$  15 mls. SE of Mbala (Abercorn), fr. *Whellan* 2123 (PRE; SRGH).

C. 32 mls. NE of "Serenje Corner", 5200 ft. alt., fl. ♂, 25.vii.1930, *Hutchinson & Gillett* 4083 (BM); 31 mls. N of Kanona, bud, 14.vi.1960, *Leach & Brunton* 10043 (K; LISC; NDO; PRE; SRGH); between Serenje and Mpika, fl. 16.vii.1930, *Pole Evans* 2897 (PRE; SRGH); Shiwa Ngandu, 5400 ft. alt., st. 22.vii.1938, *Greenway* 5472 (NDO); Kundilila Falls, E of Kanona,  $\pm$  5000 ft. alt., *Williamson & Simon* 546 (SRGH).

E. Lundazi, fl. 16.viii.1965, *Fanshawe* 9275 (SRGH).

Note: *Fanshawe* 3870, Kawambwa is included here mainly on the basis of its locality, and that *Williamson* 1351, also from Kawambwa, appears to be a good match for the variety. However its thinly 3-winged branches and  $\pm$  obsolete spinescence may indicate the desirability of further investigation of the populations in this area.

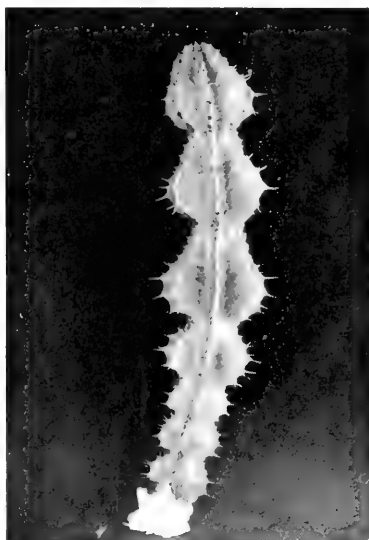
MALAWI. N. Rukuru Riv.,  $\pm$  2 mls. S of Rumpi, plants plentiful in wooded gorge, juvenile Hort. *Leach*, *Leach & Brunton* 10355.



Plant  $\pm 3.5$  m high, with remarkably regularly shaped segments and elongated persistent branches, SW of Lake Rukwa, Tanzania.



Small plant  $\pm 2$  m high,  $\pm 30$  mls. N of Kanona, Zambia.



Branch shewing gradual development of segments from small subcircular to conic-ovate. Cultivated Nelspruit.

FIG. 8. *Euphorbia cooperi* var. *ussanguensis* Leach & Brunton 10043.

Var. *ussanguensis* differs from both the typical variety and var. *calidicola* in the character of its branches, the segments of which are usually quite characteristically regularly shaped, being most frequently circular or sub-circular in outline. The winged angles are generally more stout and the usually crenate horny margins correspondingly wider (sometimes up to 10 mm). There is also a tendency for the wings to be more numerous than in either of its relatives (the count sometimes rising to nine). The "peculiar fold-like sinuations" of the margins, mentioned by N.E. Brown are, it appears, not constant in the variety, neither is this peculiarity, although certainly more prevalent in var. *ussanguensis*, restricted thereto, similar crenate margins sometimes occurring in var. *calidicola*.

The inflorescence of this variety is generally somewhat shorter than those of its two closest relatives, due mainly to the shorter, more or less straight pedicel on which the sometimes slightly smaller capsule is borne.

Var. *ussanguensis* is possibly the most clearly differentiated of the three taxa, and considered in relation to typical plants of var. *calidicola* would probably be separated at specific level; however, the overall similarity and the extent to which they approach each other at the lower and upper extremes of their respective altitudinal ranges seems to leave little doubt regarding their conspecific identity.

The straight stout pedicel probably constitutes the most distinctive character of this taxon, and the author several times debated whether or not separation should be at subspecific level. However, the length of this organ is quite variable in the other two taxa involved; it seemed therefore, to be merely part of the general pattern of variation. In these circumstances it was finally decided that varietal rank was most appropriate.

Seedlings of var. *ussanguensis* are nearest in appearance to those of var. *cooperi* but are of generally stouter habit, usually with more, more deeply winged angles, and have a tendency to branch more freely and at an earlier stage.

This variety occurs generally at altitudes of 4000—6000 ft.; its known distribution extends northward from near Serenje in the Central Province of Zambia, possibly to beyond Ngorongoro Crater and Mwanza at the southern end of Lake Victoria, and eastward to the escarpment beyond Iringa. Its occurrence in the neighbouring Congo Republic is also thought to be most probable.

(3c) Var. ***calidicola*** Leach, var. nov.

*Euphorbia* sp. 1, White, For. Fl. N. Rhod.: 199 (1962).

*Euphorbia angularis* sensu Boughey in Jl S. Af. Bot. **30**: 162 (1964).



A varietatibus affinibus ramorum segmentis formis et magnitudinibus variantissimis, alis tenuioribus paucioribus, marginibus corneis tantum c 3 mm latis, valde vel leviter sinuato-dentatis vel interdum crenatis; inflorescentia plerumque longiore, capsula longiore exserta pedicello longiore differt.

Type: Rhodesia, Wankie Distr.: *Leach & Cannell* 14103 (K; LISC; SRGH, Holo.).

ZAMBIA. E. Petauke, E. bank of Luangwa Riv., near bridge, 5.ix.1947, *Greenway & Brenan* 8057 (PRE). S. Lusitu, hillsides N of Kariba, fl. 22.v.1961, *Fanshawe* 6605 (NDO); *ibid.* *Williamson* in *Leach* 13538 (FHO; NDO; PRE; SRGH).

RHODESIA. N. Between Sebungwe Drift and Binga, fl. 14.v.1955, *Plowes* 1849 (PRE; SRGH).

W. Wankie Distr.: Deku/Shashachunda Riv. junct. fl. 16.vii.1968, *Cannell* 52 (K; LISC; SRGH), *ibid.* fr. 24.viii.1968, *Leach & Cannell* 14103 (K; LISC; SRGH), 14103A (K; PRE), 14103Aa (K; MO; PRE; ZSS); Deku Riv. 26.iv.1959, *Leach* 8964 (PRE; SRGH); Lukosi Riv., 28.iv.1959, *Leach* 8972 (PRE; SRGH); near Inyantue Riv. 29.iii.1963, *Leach* 11611 (BR; EA; K; LISC; PRE; SRGH); Deku Riv., 31.iii.1963, *Leach* 11620 (K; FHO; PRE; SRGH);  $\pm$  10 mls. S of Wankie, fr. 24.viii.1968, *Leach & Cannell* 14104 (LISC; SRGH).

MALAWI. S. Monkey Bay, Lake Malawi, *Eccles* s.n. (SRGH); Mpatamanga Gorge, Shire Riv.  $\pm$  1100 ft. alt., fl. 16.viii.1960, *Leach* 10458 (B; BR; K; PRE; SRGH).

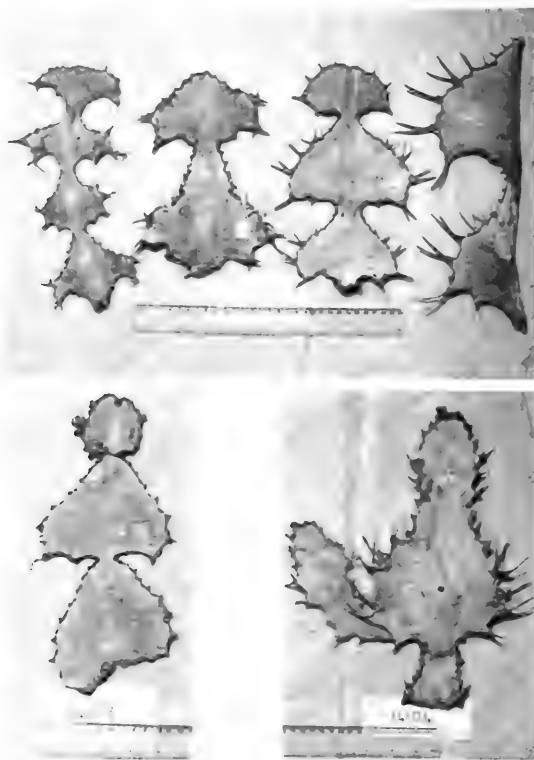
MOÇAMBIQUE. T. Tete Distr.: Mazoe/Luenha Riv. junct., fl. 6.v.1960, *Leach* 9935 (BR; K; LISC; MO; PRE; SRGH; ZSS); near Mazoe Riv. Br., fl. 6.v.1960, *Leach* 9938 (G; K; LISC; SRGH);  $\pm$  1 mile NE of Tete, fl. 17.viii.1960, *Leach* 10459 (K; PRE; SRGH).

MS. Manica e Sofala Distr.: between Tambara and Belo, broken basalt ridges below Lupata Gorge, fl. 14.vii.1969, *Leach & Cannell* 14330 (BM; K; LISC; LMA; SRGH).

Var. *calidicola* differs from the typical variety in having branches which are constricted into segments of extremely variable shape and size, with fewer broader wings only about 3 mm thick at the margins, which may be strongly or weakly sinuate-toothed or sometimes crenate and are often flexuately undulate. Spinescence is also very variable, sometimes, although rarely, on very robust specimens almost rivalling that of *E. grandicornis*, but more usually



Mr. I. C. Cannell examining plant at Deka Valley, Wankie Distr., Rhodesia. *Leach & Cannell 14103.*



Variation in spinescence and segment shape of specimens from Wankie District, Rhodesia.

FIG. 9. *E. cooperi* var. *calidicola* Leach.

it is weak and often almost obsolescent. The inflorescence is usually longer than that of var. *cooperi*, with the capsule usually relatively far exerted on a pedicel up to 10 mm long; this however, appears to be a variable character, as it is also in the typical variety, in which equally long pedicels may occasionally be found.

A tendency to develop secondary and tertiary cymes, previously noted in respect of *E. angularis* is also to be observed in this taxon. Since, however, this tendency appears to develop only at some localities it is thought that it may be due to ecological conditions rather than to any inherent genetic influence.

The distribution of this variety appears to be restricted to the lower altitudes in the hot dry valleys of the Zambesi and some of its tributaries, from Wankie to its confluence with the Shire River, where its occurrence overlaps territorially with that of *E. halipedicola*; upstream along the Shire River plants are to be found near Port Herald, and, in dense woodland, at Mpatamanga Gorge, and again on the western shores of Lake Malawi (Nyasa) in the vicinity of Monkey Bay.

Oddly enough it does not appear to occur to the east of the Shire Riv. or the Lake; the writer has certainly not seen it, nor does it appear to be otherwise recorded.

Seemingly it is a strictly riverine variety which, like the typical, tends to form relatively densely populated colonies, although usually in more open situations; smaller and more scattered groups occurring in thickets or woodland.

It is perhaps of interest to note that the distribution of this taxon (that portion from Wankie to the Kafue Riv. confluence) coincides almost exactly with that of the equally variable and polymorphic *E. persistentifolia* Leach; the two, frequently growing socially, are often associated, although usually less closely, with a third rather variable species: *E. malevola* Leach.

The occurrence of these three variable representatives of three distinct groups in the same area (a fourth: *E. fortissima* Leach is scarcely to be described as very variable) leads one to speculate on the possible evolutionary implications, particularly in relation to some less variable but closely related species from contiguous or connected areas.

#### EUPHORBIA GRANDICORNIS

Although the exact type locality of *E. grandicornis* is not known there appears to be no doubt regarding the identity of this distinctive species which is still plentiful in Zululand today.

The first valid description, published by N.E. Brown in 1897 was, according to Carter in Flow. Pl. Afr. **36**: t.1408 (1963), based on a plant cultivated at Kew, which was collected by Stone in Zululand, near the Umfolozi River.

The epithet "*grandicornis*" had, it seems, been in use for some while prior to 1889 and has, since that date, generally been attributed to Goebel; however, his publication was unaccompanied by an adequate description and must, therefore, be considered to be a *nomen nudum*.

(4) *Euphorbia grandicornis* [Goebel in Pflanzenbiol. Schild. **1**: 42 (1889) nom. nud.]; Goeb. ex N.E. Br. in Hook. Ic. Pl. **26**: t.2531, 2532 (1897).—Berger, Sukk. Euphorb.: 52 (1907).—N.E. Br. in Fl. Cap. **5**,2: 367 (1915) pro parte excl. syn. *E. breviarticulata*.—R.A. Dyer in Flow. Pl. S. Afr. **17**: t.642 (1937) p.p. et in Cact. Succ. Journ. Americ. **9**: 83 (1938), p.p.—White, Dyer & Sloane, Succ. Euphorb. **2**: 861 (1941) p.p. excl. syn. *E. breviarticulata*.—Jacob. Handb. Succ. Pl. **1**: 435 (1960) p.p. excl. distrib. Tanzania and Kenya. —Carter in Flow. Pl. Afr. **36**: t.1408 (1963).—Compton, Swazil. Check List: 53 (1966).—Type: cult. Kew, "Zululand" *Stone* s.n. (K!).

*Euphorbia grandidens* sensu Goeb., loc. cit.: t.15, non Haw.

The distribution of this species appears to be restricted to lowveld areas (generally below 1500 ft. altitude) of Zululand, Swaziland, and the Lourenço Marques and Sul do Save Districts of Moçambique, to as far north as Chibuto, not far from Vila de João Belo. There is also a strangely disjunct population, now considered to be distinct at subspecific level, to be found on granite slopes in the vicinity of Nampula in northern Moçambique.

*E. breviarticulata* Pax, until now generally accepted as being conspecific with *E. grandicornis* is recognised by the writer as being distinct. The reasons for this decision and the differences between the two species are discussed in the following pages.

The spines of these three taxa are usually remarkably terete, whereas those of related species, such as *E. halipedicola*, tend almost always to be flattened or oval in cross-section towards the base.

#### (4a) Subsp. *grandicornis*

Plants generally form close colonies on flats, in more or less open country, on the deep soils of the coastal plain. Branches are usually described as 3-angled but 4-winged specimens occur and may even predominate in some areas of Maputoland where the species is often found in thick bush, often associated with *E. confinalis* R. A. Dyer, *E. knuthii* Pax, *Aloe bainesii* Th. Dyer, *A. suffulta* Reyn. and numerous other succulent species.

MOÇAMBIQUE. SS. Sul do Save Distr.: Chibuto, N of Vila de João Belo, fl. 29.ix.1959, Mogg 29718 (SRGH).

LM. Lourenço Marques Distr.:  $\pm$  10 mls. S of Boane, fr. 22.vii.1961, Leach

11207 (EA; K; PRE; SRGH); Bela Vista road SW of Lourenço Marques, cult. Greendale, fl. 18.ix.1958, *Leach* 5063 (K; SRGH);  $\pm$  17 mls. N of Moamba, c 200 ft. alt., fl. 29.ix.1963, *Leach & Bayliss* 11752 (EA; SRGH); near Catuane, fl. 19.iv.1944, *Torre* 6481A (LISC);  $\pm$  10 mls. W of Lourenço Marques, st. *Van der Merwe* E15, (PRE); near Umbeluzi, fl. & fr. 20.vi.1969, *Leach* 14247 (LISC; LMA; PRE; SRGH).

SWAZILAND. 2631 (Mbabane): Stegi Distr., near Komati Canal (-B), fr. 4.ix.1959, *Compton* 29044 (PRE).

NATAL: 2731 (Louwsburg): flats between Lebombo and Magut, fr. 19.vii.1936, *Dyer* 3471 (PRE);  $\pm$  11 mls. N of Magut, *Dyer* 3474 (PRE); Magut, *Irons* s.n. (PRE); Magut bush, *Pole Evans* 2658 (PRE).

2732 (Ubombo): Mkusi Flats, Ingwavuma Distr., *Wells* 2184 (PRE).

2831 (Nkandla): Hlabisa (-BB), fl. 28.vi.1955, *Ward* 2644 (LMA; PRE); Middledrift, Tugela Valley, (-CC), *Edwards* 1430 (PRE); Mambula area, overlooking Tugela Valley, *Dyer* 4349a (PRE); near confluence of Begamusi and Black Umfolozi Riv., *Gerstner* in *Marloth* 13543 (PRE); Middledrift road. Tugela Valley, *West* s.n. (PRE). Zululand, Umfolozi Riv., hort. Kew,  $\sigma$  fl., *Stone* s.n. (K).

Subsp. *sejuncta* Leach, subsp. nov.

A subspecies typica affinis sed planta parvissima interdum procumbenti (altitudine minor quam 1 m); ramis plerumque 2—3-alatis; spinis longitudine variabilissima differt.

Type: Moçambique, *Leach & Schelpe* 11437 (K; LISC; MO; PRE; SRGH, holo.).

MOÇAMBIQUE. N. Moçambique Distr.: granite slopes  $\pm$  6 mls. E of Nampula, alt. c 1250 ft., fl. 23.vii.1962, *Leach & Schelpe* 11437 (K; LISC; MO; PRE; SRGH); *ibid.*, cult. Greendale, fl. 9.xi.1961, *Leach & Rutherford-Smith* 10967 (EA; SRGH); Serra Chinga,  $\pm$  30 km. E of Ribaué, prostrate on rocks, fr. 10.x.1968, *Macedo* 3704 (LMA).

Subsp. *sejuncta* differs from the typical subsp. in being a much smaller plant, usually attaining only  $\pm$  0.6 m in height (not exceeding 1 m) and sometimes procumbent, with 2—3-winged branches (very rarely 4-winged), 2-winged sometimes predominating: the spines, although similar in all other respects, are much more variable in length than those of either subsp. *grandicornis* or *E. breviarticulata*, although when long equalling the longest of these. In the specimens examined the male flowers were more numerous ( $\pm$  50 : 25); however, as only a limited quantity of material was available it is not known to what extent this character may vary.

In 2-winged branches and sometimes oblong segments there is a link with *E. halipedicola*, although in most other respects the taxa are quite different. Possibly of importance in this relationship is the origin and development of the prickles associated with the leaf. In the new subsp. these appear to originate in the same manner of those of *E. halipedicola*, in which the lower portions of the leaf margins persist when the remainder of the leaf falls. Subsequent development of the horny margin causes these remnants to become separated from the inconspicuous leaf scar. In subsp. *grandicornis* and *E. breviararticulata* however, the prickles appear to be distinct from the leaf at all stages of development.

Distribution appears to be restricted to granite slopes in the Nampula region, a habitat in all respects different from the coastal plains and equally distinct from the desert and semi-desert conditions under which its more northerly relative thrives.

It is because of its spatial and ecological isolation combined with its apparent links with other taxa that subspecific rank is considered to be most indicative of the possible evolutionary position of this disjunct population.

It is interesting to note that another relative, namely, *E. grandialata*, R. A. Dyer (which is closely related also to *E. cooperi*), occurs in an equally isolated habitat on dolomite hillsides in the Lydenburg Distr. of the Eastern Transvaal.

#### EUPHORBIA BREVIARTICULATA

*E. breviararticulata* was described by Pax in 1904, based on an *Engler* gathering from the West Usambaras; that this might be conspecific with *E. grandicornis* was first suggested by N. E. Brown in *Flora Capensis* (1915). This suggested synonymy appears to have been generally accepted by the majority of authors for some time past, but various differences noted during an investigation into the relationship of *E. angularis* and *E. grandicornis* caused the writer to doubt the correctness of this synonymy and it is now considered that *E. breviararticulata* should be reinstated as a species distinct from the latter.

(5) ***Euphorbia breviararticulata*** Pax in *Engl. Bot. Jahrb.* **34**: 84 (1904).—N.E. Br. in *Fl. Trop. Afr.* **6**,1: 582 (1912).—Eggeling & Dale, *Indig. Trees Uganda Prot. Ed.* **2**: 126 (1951).

Type: Tanzania, W. Usambaras, *Engler* 1184.

*Euphorbia grandicornis* sensu N.E. Br. in *Fl. Cap.* **5**,2: 367 (1915) pro parte quoad syn. *E. breviararticulata*.—R. A. Dyer in *Fl. Pl. S. Afr.* **17**: t.642 (1937) pro parte, et in *Cact. Succ. Journ. Americ.* **9**: 83 (1938) pro parte.—White, Dyer & Sloane, *Succ. Euphorb.* **2**: 861 (1941) pro parte.—Brenan & Greenway, *T.T. Check List* **2**: 213 (1949).—Jacob. *Handb. Succ. Pl.* **1**: 435 (1960)

pro parte quoad syn. et distrib. E. Africa.—Dale & Greenway, Kenya Trees, Shrubs: 198 et fig. 37 (1961).—Carter in Fl. Pl. Afr. **36**: t.1408 (1963) pro parte quoad distrib. E. Africa.

ETHIOPIA. W of Yavello, towards Sagan Riv., 4200 ft. alt., *Bally* B9258 (EA).

SOMALI REPUBLIC. Hawina, "common along road to Afmadu", c 400 ft. alt., fl. 14.ii.1941, *West* 5330 (PRE).

KENYA. Northern Prov.: Lodwar Flats, st.iii.1940, *Leakey* s.n. (EA; PRE); Lorengipe, 64 mls. S of Lodwar, 2500 ft. alt., st. 11.iv.1954 (EA); SW of Lodwar, foot of escarp., Moroto road, fl. 9.x.1952, *Verdcourt* 806(EA); Moyale, 15 km towards Wajir, 2600 ft. alt., st. 20.viii.1952, *Gillett* 13734 (EA); Turkana Desert, st. *Pole Evans & Erens* 1566 (PRE). Coast Province, near Voi, fr. 14.vii.1960, *Leach & Bayliss* 10241 (EA; K; PRE; SRGH).

TANZANIA. Northern Prov.: S. Pare Mtns. between Makanya and Hedaru,  $\pm$  2000 ft. alt., fr. 8.vii.1942, *Greenway* 6576 (EA; PRE); Steppe E of Pare Mtns., near Kihurio, 17.xii.1901, *Uhlig* s.n. (EA).

Note: Some specimens from the southern Somali and Kenya coast as well as the W. Usambaras appear to be somewhat intermediate between plants of the Tanzanian coastal populations and the inland *E. breviariculata*; these, as well as those from the Tanzanian coast require further investigation.

The most important difference, in the writer's opinion, between *E. grandicornis* and *E. breviariculata* lies in the entirely different arrangement of the inflorescence. That of *E. grandicornis* is of the more conventional pattern, in which 1—3 cymes are produced from each flowering eye, these being arranged horizontally, i.e. at right-angles to the margin, each bearing 3 cyathia vertically arranged; whereas that of *E. breviariculata* comprises a number of cymes (up to 6 seen) haphazardly arranged. This arrangement seems, perhaps, to be implicit in Pax's original description, which includes "inflorescentiae umbelliformis ramis 3—4 crassiusculis 4 mm crassis semel dichotomis"; "umbelliformis ramis 3—4" seeming to indicate some arrangement differing from that usually found in the spine-paired species. A further distinguishing character is the nature of the initial central cyathium which, in Pax's species appears always to be male deciduous (? "semel dichotomis") but in *E. grandicornis* seems usually, if not always, to be persistent (as in the associated *E. cooperi*).

The cymes of *E. breviariculata* are usually considerably longer than those of its relative, particularly in fruit, when the larger (14.5—15.5 mm diam.: 10—12 mm), more deeply lobed, apically truncate (somewhat pyramidal in *E. grandicornis*) capsule is exserted, usually well clear of the involucre on a stout

pedicel about 5 mm long ( $\pm 2-2.5$  mm in *E. grandicornis*); the styles of Pax's species are free almost to the base, those of the S. African plants being united for about half their length. In the material dissected the male flowers have been found to be more numerous in *E. breviarticulata* (38 : 22) but it is not possible to judge the extent to which this may be constant as only a few specimens have been examined for this character.

Finally the segments of the East African plants appear to be more or less uniformly twice as broad as long, whereas in *E. grandicornis* these dimensions are generally more or less equal.

Pax's description appears to be drawn up from a very small specimen with segments only 6 cm broad  $\times$  3 cm long, with correspondingly shorter spines only 2.5 cm long as compared with the more normal 4.5-5 (6) cm of the material examined.

The reported difference in gland surface is thought to be unimportant, since this appears, at least to some extent, to be dependent on the age of the glands.

*E. breviarticulata* inhabits the desert and semi-desert areas of East Africa, its known distribution extending from the Usambaras in Tanzania to southern Somalia and Ethiopia. Its occurrence appears, from the records, to be of a somewhat sporadic and intermittent nature, but this may be due, in part to the understandable unpopularity with collectors, of the more spiny members of the genus.

#### EUPHORBIA HALIPEDICOLA

(6) ***Euphorbia halipedicola*** Leach, sp. nov.

*Euphorbia angularis* N.E. Br. in Fl. Trop. Afr. **6**, 1: 585 (1912) pro parte quoad specim. Kirk.—White, Dyer & Sloane, Succ. Euphorb. **2**: 882 (1941) pro parte quoad fig. 1005 et distrib. Zambesi.—Jacob. Handb. Succ. Pl.: 406 (1960) pro parte quoad distrib. Zambesi.

*Euphorbia nyikae* sensu Reynolds, Aloes Trop. Afr.: Pl. 37 (1966).

*E. breviarticulatae* Pax affinis sed planta altiore trunco centrali: ramorum segmentis plerumque oblongis longissimis; spinis plerumque brevioribus basin versus compressis; bracteis grandioribus; involucre lobis grandissimis forma dissimili; floribus masculis numerosioribus; stylis plus minusve duplo longioribus ad medium in columnam connatis bene distincta.

*Frutex* vel arbuscula, succulentus, spinosus, plerumque ad 4-5 m altus (interdum ad 10 m); trunco crasso; ramis patulis, saepe primo descendentibus, arcuato-ascendentibus, plerumque demum erectis, saepe truncum valde superantibus; rami inferiores interdum cadentes, planta tum habitu arbusculae. *Truncus* aliquantum segmentatus, initio 3-angulatus, mox 4-6-angulatus,



denique plus minusve cylindricus. *Rami* plus minusve verticillati, pauci ramosi, 3—4-alati (plerumque 3), valde in segmenta constricti, basi in stipitem lignosum plus minusve teretem angustati; *rami secundarii* ramulisque plerumque 3-alati, segmentorum basin versus ex marginibus alarum prodientes. *Segmenta* plerumque oblonga vel apicem versus gradatim leviter angustata, usque ad 32 cm longa (40 cm)  $\times$  20 cm lata, interdum late triangularia vel plus minusve late ovata; *alis* latissimis, tenuissimis, ramo centrum versus quam marginibus vix crassioribus; *marginibus* prominenter crenato-dentato, valde undato, corneo, continuo, primo rubro-brunneo, tandem cinerascenti, usque ad 2 mm crasso, in spinis et inflorescentiis lato facto; inflorescentia variabiliter posita, basi plerumque spinis binis (interdum 4) necnon saepe spinulis armata. *Folia* carnosa, plus minusve circularia vel ovata, acuta vel apiculata, recurva, c 3 mm longa, decidua cicatricibus obsolescentibus; marginibus lateralibus rubro-brunneis, textura podariis similibus, mox secedentibus, tandem spinulas formantibus. *Spinae* binae divergentes patentes, usque ad 1.5 cm longae, aliquantum compressae basin versus. *Inflorescentia* glabra, cymosa; cymis pedunculatis 1—5, fortuito-dispositis, unaquibusque cyathiis 3; *pedunculus* bibracteatus, plus minusve stipiformis, aliquantum lateraliter compressus, 4—5.5 mm diam., 7—12.5 (4) mm longus. *Bracteae* plus minusve ovatae, subacutae, 5.5—7 mm latae, 4—5.5 mm longae, carnosae, plerumque scissae. *Cymae* cyathio initio masculo sessili deciuo; cyathiis lateralibus bisexualibus; cymarum ramis 10—12 mm longis, basi c 4 mm diam., versus apicem paulo ampliatis compressisque; bracteis plus minusve late ovatis, saepe scissis, denticulatis, usque ad 7 mm latis, 5—6 mm longis, involucrium aequantibus vel hoc saepe paulo superantibus. *Involucrium* cyathiforme, 8—10 mm diam., c 6 mm longum; *glandulis* 5—6, transverse late ellipticis vel depresso obovatis, 4—5 mm latis, 2.75—3.5 mm longis, transverse, plicato-convexis marginibus transversis integris protentis valde uni-undatis; *lobis* 5—6, cuneato-obovatis, fimbriato-dentatis, interdum parum lobatis, aliquantum acute plicato-carinatis, c 2.5 mm longis, 1.75—2 mm latis. *Flores masculi* c 50, bracteolis filiformi-divisis numerosis, inaequaliter 5—6-fasciculati; bracteae fasciculares filiformi-laceratae, c 5 mm longae, ad 2 mm latae; pedicelli 4.5—6 mm longi; filamenta 1.5—1.75 mm longa. *Ovarium* subglobosum, perianthio lobato insidens, perianthii lobis inaequaliter longe attenuatis; partibus attenuatis in fructibus obsolescentibus; ovulum sub obturamento sub lobato minute denticulato cucullato parvulo dependens. *Styli*, c 4.5 mm longi, e basi in columnam crassam, obtuse trigonam, c 2 mm longam, 0.5 mm diam. connati; partibus libris patulis, intus leviter unicastatis, aliquantum canaliculatis versus apicem ampliatum breviter bifidum rugulosum. *Capsula* profunde trilobata, basi necnon apice truncata vel saepe apice aliquantum obtusa, 18—21 mm lata, c 8 mm alta, ex involucrio exserta pedicello crasso, plus minusve cylindrico (plerumque aliquantum ampliato

basin versus), 7—8 mm longo, 3—3.5 mm diam. *Semen* subglobosum, c 3.5 mm diam., cremeum vel bubalinum, variabiliter maculosum, maculis flavidis, rubro-brunneis vel atro-purpureis.

The foregoing description was drawn up from *Leach & Wild* 11130 (flowering material) and *Leach* 9182 (fruiting material), both being collected from the same population and probably from the same individual.

Type: Moçambique, Manica e Sofala Distr., c 34° 17' E: 19° 36' S; *Leach & Wild* 11130 (K; LISC; PRE; SRGH, holo.).

Native name (Sena): "MUCONDE" (Torre & Paiva).

MOÇAMBIQUE. N. Moçambique Distr.: Lumbo, fl. 11.viii.1964, *Leach* 12371 (K; SRGH).

Z. Zambesia Distr.: between Mopeia and Campo, st. 12.ix.1944, *Mendonça* 2041 (LISC).

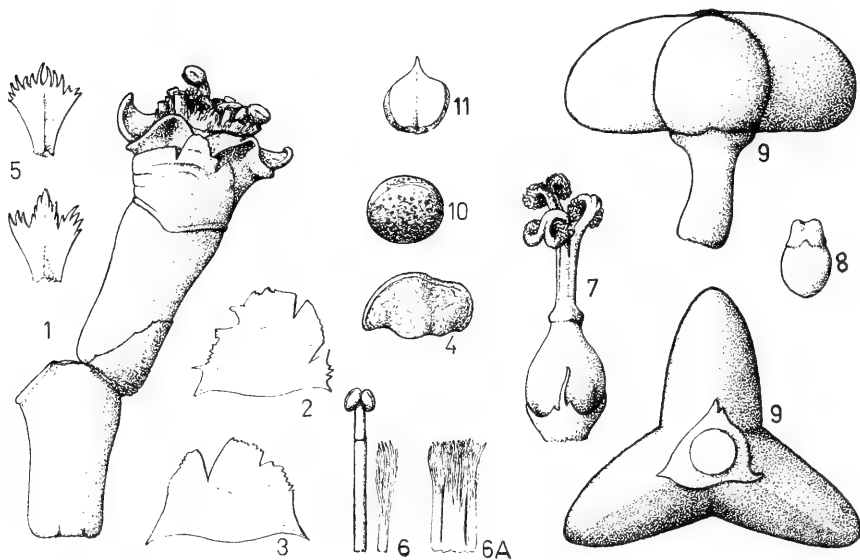


FIG. 10. *Euphorbia halipedicola* Leach.

(1) Portion of cyme ( $\times 3$ ); (2) Bract (Cyme branch)—( $\times 3$ ); (3) Bract (Involucre)—( $\times 3$ ); (4) Gland—( $\times 3$ ); (5) Lobes—( $\times 5$ ); (6) Male flower and bracteole ( $\times 3$ ); (6A) Fascicular bract—( $\times 3$ ); (7) Gynoeceium—( $\times 5$ ); (8) Ovule—( $\times 5$ ); (9) Capsule—( $\times 2$ ); (10) Seed—( $\times 3$ ); (11) Leaf—( $\times 3$ ).

MS. Manica e Sofala Distr.: Lupata, lower Zambesi, fr. June 1859 *Kirk* (K); Shiramba, lower Zambesi, ic.361 del. *Kirk* 16.vi.1859 (K); Parque Nacional de Caçç, Gorongosa, fl. 30.iv.1964, *Torre & Paiva* 12315 (LISC); *ibid.* cult. Umtali, fr. 5.xi.1967, *Cannell* s.n. (SRGH); *ibid.* fl. 8.vii.1969, *Leach, Cannell & Tinley* 14253 (K; SRGH); near Lake Gambue, fr. 30.vi.1959, *Leach* 9182 (LISC; PRE; SRGH), *idem*, seedling cult. Greendale, *Leach* 9182A (SRGH), *idem*, cult. Nat. Bot. Gard. Salisbury, fl. & fr. May 1968 (K; SRGH); *ibid.* fl. 22.vi.1961, *Leach & Wild* 11130 (K; LISC; PRE; SRGH).

SS. Sul do Save Distr.:  $\pm$  10 mls. S of Mambone, st. 9.x.1963, *Leach & Bayliss* 11888 (LISC; PRE; SRGH); *ibid.* cult. Nelspruit, fl. & fr. 30.vii.1966, *Ambrose* s.n. in *Leach* 11728 (K; LISC; SRGH).

Note: *Torre* 5445 from Mocuba, Zambesia Distr., probably belongs here but the atypical segment shape and its habitat on a rock outcrop leave some room for doubt regarding its identification.

*E. halipedicola* is, in fact, probably most closely related to the plants abounding on the East African coast to the north of Dar-es-Salaam, but as there is considerable doubt regarding the identity of this population and the possibility of its hybrid origin cannot be disregarded, it has been considered advisable to base the diagnosis on the slightly less closely related but more definitely circumscribed *E. breviarticulata*.

From this latter the new species may be readily distinguished by its taller stature and stout central trunk, while the usually oblong, relatively long branch segments are quite distinct from those of *E. breviarticulata*, as are also the shorter spines which are somewhat compressed towards their base; the inflorescence with its larger bracts; much longer, differently shaped involucre lobes; more numerous male flowers and styles which are twice as long and united into a stout column for half their length, is also quite distinctive.

The Dar-es-Salaam population is so extremely variable in segmentation, spinescence, habit and stature, as well as in flowering and fruiting characters that it is thought quite possibly to be of hybrid origin. Some individuals and all the seedlings found, closely resemble those of the Moçambique populations, particularly in their oblong segments with characteristically wavy margins [clearly to be seen in the photograph of a plant on the Zambesi at Sena, in Reynolds, *Aloes Trop. Afr.*: t.37 (1966)]. However, it does seem that the Tanzanian plants have, as a general rule, smaller somewhat differently shaped capsules, while the small, subquadrate, shortly dentate involucre lobes of all the flowering material examined, are quite different from the most distinctive, fimbriate-toothed, cuneate lobes of the new species from the Flora Zambesiaca area.



Typical oblong segments with strongly wavy margins.



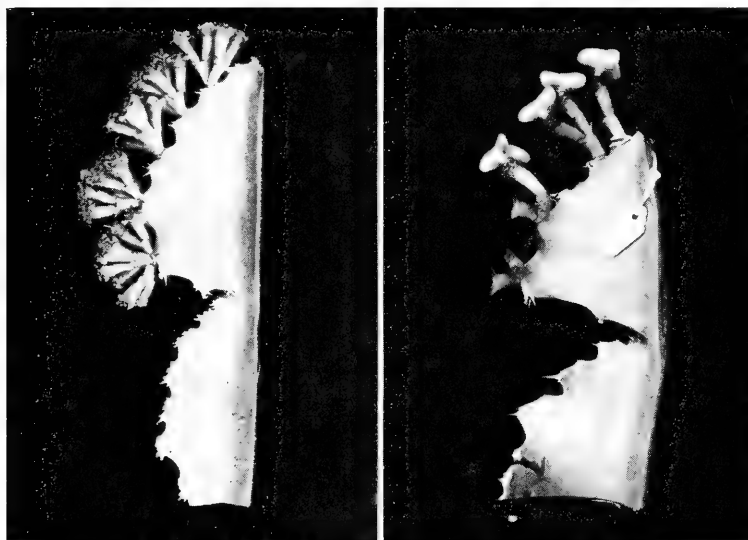
Plant  $\approx$  5 m high, at the type locality, near Lake Gambue, with *Aloe marlothii* Berger and *Hyphaene* sp.

FIG. 11. *Euphorbia halipedicola*.

The recorded distribution of the new species extends southward, on the low-lying coastal plain of Moçambique, usually in areas of seasonal or perennial vleis, generally in or at the margins of thickets and small patches of woodland, often in association with *E. lividiflora* Leach, *Aloe marlothii* Berger and *Hyphaene* sp., from Lumbo in the north to a few miles south of Mambone at the mouth of the Save River, in the Sul do Save District. Along the lower Zambesi there may be a slight distributional overlap with *E. cooperi* var. *calidicola*, but it is felt that the two taxa should scarcely be confused as they are so easily distinguished from each other by their respective segment shapes.

Plants appear to be most plentiful in the western portion of the Parque Nacional da Gorongosa, where large numbers are to be found, with some specimens up to 10 m tall and with the general aspect, from a distance, of large specimens of *E. cooperi*. Elsewhere colonies are less densely populated and appear to be of very scattered occurrence.

It was not possible, unfortunately, to locate any specimens of the new species in the vicinity of Kirk's localities (Chiramba and Lupata) although apparently eminently suitable habitats abounded, but it is thought that this is probably



Flowering segment with crowded, randomly arranged cymes *Leach & Wild* 11130.

Fruiting segment (some cymes removed) showing deeply lobed capsules *Leach* 9182.

FIG. 12. *Euphorbia halipedicola*.

accounted for by the extensive shifting cultivation, particularly of cotton, which appears to have been effected all along the southern bank of the Zambesi.

*Plant*: a spiny, succulent shrub or small tree, usually up to 4–5 m high (sometimes up to 10 m), with a stout trunk and spreading, often at first descending, arcuate-ascending, usually finally erect branches, which often much exceed the central trunk; the lower branches sometimes falling, plants then assuming a more tree-like habit with a more or less rounded crown of branches. *Trunk* somewhat segmented, initially 3-angled, soon becoming 4–6-angled, more or less cylindric when plants become tree-like. *Branches* more or less whorled, sparingly rebranched, 3–4-winged (mostly 3), deeply constricted into segments, narrowed at the base into the stalk-like, more or less terete, central woody core; secondary branches and branchlets usually 3-winged, arising from the wing margins near the base of the segments. *Segments* mostly oblong or slightly tapering, up to 32 cm long (40 cm)  $\times$  20 cm broad, sometimes broadly triangular or more or less ovate; with broad, thin wings up to 2 mm thick at the prominently crenate-toothed, strongly undulate margins, which are scarcely thicker towards the small central core; with a narrow continuous horny margin, reddish brown at first, becoming whitish grey, broadening at the spine pairs and at the flowering eyes; flowering eye variable in position from shortly above to about half-way between the spine pairs, generally somewhat prominent and areole-like, usually armed with a pair (sometimes 4) of spreading, initially flattened spines up to 4 mm long and often with a number of prickles. *Leaves* more or less circular or ovate, acute or apiculate, recurved, c 3 mm long, fleshy, with red-brown lateral margins (of similar texture to that of the spine shields) which soon separate from the deciduous portion of the leaf and develop into the obsolescent prickles flanking the inconspicuous, depressed obovate or very shallowly obtriangular, obsolescent leaf scar. *Spines* in diverging spreading pairs, up to 15 mm long, longest at the widest part of the wings, usually somewhat compressed towards their base. *Inflorescence* glabrous, cymose, with 1–6 randomly arranged, pedunculate cymes of 3 cyathia; *peduncle* bibracteate, rather stalk-like, somewhat laterally compressed, 4–5.5 mm diam., 7–12.5 mm long (4 mm). *Bracts* subtending the cyme branches more or less broadly ovate, subacute, 5.5–7 mm wide, 4–5.5 mm long, fleshy, usually somewhat split and deteriorated. *Cymes* with the initial, sessile, central cyathium male, deciduous, and lateral bisexual cyathia borne on cyme branches 10–12 mm long, c 4 mm diam. at the base, becoming somewhat enlarged and laterally compressed towards the bibracteate apex. *Bracts* usually split, more or less broadly ovate, denticulate, up to 7 mm wide, 5–6 mm long, equalling or often exceeding the involucre. *Involucre* cup-shaped, 8–10 mm diam., c 6 mm long; *glands* 5–6, transversely broadly elliptic or depressed obovate, 4–5 mm wide, 2.75–3.5 mm long, with the transverse entire margins lengthened, and conse-

quently somewhat wavy, the outer more than the inner and raised in a single central fold-like undulation so that the gland becomes rather sharply transversely convex; *lobes* 5—6, cuneate obovate, rather sharply plicate-keeled, fimbriate-toothed, often somewhat lobed, 2·5 mm long, 1·75—2 mm wide. *Male flowers* c 50, with numerous filiform-divided bracteoles, arranged in unequal fascicles (averaging 10 flowers each); each fascicle subtended by a filiform-laciniate internal bract c 5 mm long, up to 2 mm wide; *pedicels* 4·5 mm long; *filaments* 1·5—1·75 mm long. *Ovary* subglobose, seated on a lobed perianth with lobes of very unequal length (the attenuate portions of which become obsolete in fruit); *ovule* suspended under a somewhat two-lobed, minutely denticulate, hood-like obturator. *Styles* c 4·5 mm long, united at their base into an obtusely trigonous stout column c 2 mm long, 0·5 mm diam., the free portions somewhat ribbed down the inner face, becoming grooved towards the enlarged, shortly bifid, rugulose apices. *Capsule* deeply 3-lobed, 18—21 mm across the lobes, c 8 mm high, truncate at both base and apex, often somewhat rounded at the apex, exerted from the involucre on a more or less cylindric, stout pedicel (usually slightly enlarged towards the base), 7—8 mm long, 3—3·5 mm diam. with a fleshy somewhat 3-lobed perianth c 6 mm diam. *Seed* subglobose, c 3·5 mm diam., cream or buff-coloured, with rather variable, yellowish to dark reddish-brown or blackish purple mottling and speckling; suture slightly raised for rather more than half its length, dark brown.

#### EUPHORBIA NYIKAE COMPLEX

***Euphorbia nyikae*** Pax in Engl. Pfl. Ost-Afr. "C": 242 (1895).—No type cited.

The very brief description tells us that it is a 20 m tall tree; "ramis crassis (more Phyllocacti)" appears to be something of a contradiction, but it is thought that "crassis" may here mean overall diam. or width since it is followed by "plano-compressis" which together with the reference to Phyllocacti would appear to indicate flat thinly winged branches (N. E. Brown in Fl. Trop. Afr. notes that the type specimen of *E. nyikae*, presumably *Volkens* 51, is "flat and two-winged at the base and four-winged at the apex and the wings very thin"), and "podariis parvis" small, probably separate spine shields, while the cyathia are said to be arranged in 3 or fewer flowered dichasia.

In Engl. Bot. Jahrb. 33: 533 (1897) Pax cites *Volkens* 51 as the type and adds that the branches are up to 5 cm wide, the spines 6 mm long, the cyathia 6—7 mm diam. with small bracts and simple styles.

Finally in Engl. Bot. Jahrb. 34: 73 (1905) again citing *Volkens* 51, he tells us that it is a 15 m tall tree, with branch segments 10—20 cm long and spines 1—1·5 cm long. There seems to be some discrepancy here when this is compared with his earlier descriptions.

The more comprehensive description provided by Volkens in Notizbl. Bot. Gart. Berl. appears to the writer unfortunately to include possibly more than one species, or at least to be based on specimens differing from those of Pax's two earlier descriptions, and also perhaps to have provided the basis, at least in part, for Pax's third, somewhat different description.

In addition to the apparent discrepancies between the various descriptions there seems also to be some doubt regarding the localities involved.

The confusion surrounding this species and others from East Africa seems to have persisted down to the present day; no two authors seeming to be in complete agreement regarding either identities or synonymy. There are certainly several species involved, some being quite distinct from each other in their widely differing floral characters.



Plant  $\pm$  10 m high, at the type locality, Kibwezi, Kenya, Leach & Bayliss 10242.

FIG. 13. *Euphorbia kibwezensis*.



To the writer it appears:—

(1) That *E. nyikae* is probably identifiable with the tall trees to be seen on the slopes of the Usambaras above Mombo but that the shrubs and small trees at lower altitudes in the Pangani Riv. valley and elsewhere, belong to a different, probably undescribed taxon, which may be conspecific with those plants inhabiting the coastal regions.

(2) That *E. bussei* may be equal to *E. nyikae* but that the original description of a plant with a tall cylindric trunk from an inland locality appears to make the identification of Dr. Busse's photograph in Engl. Pflanzenw. Afr. (Engl. & Drude, Veg. Erdr) 9, 1: 228, fig. 200 (1910) of a plant at Dar-es-Salaam, rather doubtful. The identical photograph was later re-identified in Engl. & Prantl, Pflanzenfam. Ed. 2, 19c: 15, fig. 7 (1931) as *E. nyikae*, apparently in acceptance of the synonymy of *E. bussei* with *E. nyikae* and satisfied that the photograph was correctly identified.

(3) That *E. kibwezensis* appears to be distinct from the foregoing, being perhaps closest to *E. cooperi* complex, which, it is thought, may possibly extend to areas much further north than those covered by the present paper.

(4) That *E. mbaluensis* Pax and *E. intercedens* Pax may be conspecific but appear to differ from all the foregoing.

However, whatever the final unravelling of this tangled skein may be, it seems that, except for the possible extension of *E. cooperi* complex, the taxa involved are excluded from both the *E. angularis-cooperi* and *E. grandicornis* groups by what appear to the writer to be reliable characters.

#### ACKNOWLEDGEMENTS

The author is much indebted to and wishes to thank: Almirante I. Moreira Rato, Director dos Serviços de Marinha, Lourenço Marques in 1961, and his successor in that post, Almirante Cardoso de Oliveira, for permission to visit Goa Island; also Commander Gaspar, Port Captain at the Port of Moçambique, for transport facilities and his active co-operation and hospitality, and his successor Commander Menezes, for arranging transport facilities on the occasions of his visits to Goa Island.

Dr. L. E. Codd, Chief, Botanical Research Institute, Pretoria (PRE) for the facilities of the herbarium, for his personal interest over many years and for reading this paper and for helpful comments thereon.

The Director, Royal Botanic Gardens, Kew, for photostat copies of pages from literature not otherwise available and for the loan of material including

several types; also to the Directors of The Bolus Herbarium, University of Cape Town (BOL), the East African Herbarium, Nairobi, Kenya (EA), the Centro de Botânica da Junta de Investigações do Ultramar, Lisboa (LISC), Direcção de Agricultura e Florestas, Lourenço Marques (LM; LMA), and the National Botanic Gardens, Kirstenbosch, Cape Town (NBG), for the loan of much valuable material.

Mr. R. B. Drummond, Chief Botanist, Government Herbarium, Salisbury (SRGH), for the facilities of the herbarium and assistance in many directions.

Mr. & Mrs. T. Brunton & Mrs. R. P. Ellis, Messrs. R. D. Bayliss, I. C. Cannel, H. H. Mockford and R. Rutherford-Smith, and Professors E. A. Schelpe and H. Wild, for their companionship and assistance during various excursions and expeditions.

Mr. & Mrs. M. N. Ambrose, Mr. & Mrs. E. J. Bullock, Messrs. I. C. Cannel, W. Riley and J. Whellan and Dr. G. Williamson for plants, photographs and material.

Eng. Gomes e Sousa for a map and information concerning Goa Island, and Messrs. Th. Müller and H. Tölken for their help in translating passages from the German literature.

All those contemporary workers who, in conversation and correspondence, have drawn attention to so many aspects of these problems, particularly in this respect to Dr. R. A. Dyer and Mr. P. R. O. Bally.

## BOOK REVIEW

*Plant Science*: An introduction to world crops by Jules Janick, Robert W. Schery, Frank W. Woods and Vernon W. Ruttan. viii plus 629 double column pages, with a large number of tables, illustrations, photos and maps. San Francisco: W. H. Freeman & Co., 1969. Price \$12.00.

This book covers a wide field to which each of the four authors contributed in his own particular branch of study, but in such a way that the contents form a well-balanced whole. The book consists of 27 chapters, divided into six parts, viz. plants and men; nature of crop plants; plant environment; strategy of crop production; industry of plant agriculture and the marketplace. The plant, which is the central theme, forms the basis of most of the energy needed for industrial purposes, in the form of gas and coal; for transport in the form of petroleum—all stored energy captured from the sun by plants aeons ago. Similarly, the plant forms the basis of human feeding and energy, directly or indirectly through the animal products utilized as food. The problem of population explosion, resulting in inadequate food supply, is also discussed, in addition to primitive methods of crop production, through the transition of mediaeval to modern practices, known as the agricultural revolution.

Botanical concepts, such as the origin and classification of plants, structure, growth, reproduction and function are discussed in part two of the book, followed by the influence of environment on plants and crops specifically. In parts four and five particular attention is paid to principles and practices of crop production, and to specific food crops, fruits, fibre crops, forest trees and ornamental shrubs. In conclusion the economic aspect of crop production, distribution and marketing are taken into account.

The expressed object of the authors was "... to give attention to the scientific, technological and economic foundations of world crop production ...", because these sciences "... have become irrevocably entwined." Undoubtedly the authors have succeeded very well in presenting a complete, well-rounded view of crop science and its basic, increasing importance in our existence, in a single book. The book contains a wealth of information and although planned as an introductory course for students in agriculture and biology, it should interest a much wider circle of readers outside the particular discipline, as it is written in a comprehensible, narrative style; besides, the well-being of every individual is intimately related to the plant.

J. H. HOFMEYR



# INSTRUCTIONS TO CONTRIBUTORS TO THE JOURNAL OF SOUTH AFRICAN BOTANY

This Journal provides a medium for the publication of the results of botanical research primarily on the flora of Southern Africa, whether systematic, morphological, ecological or otherwise and whether carried out in South Africa or elsewhere. Papers on botanical subjects of special interest and application in South Africa may be included.

Contributions must be original and should not be translations of previously published papers.

Papers must be submitted in final, corrected form. They are accepted for publication on the recommendation of the Editorial Committee.

Authors may be charged expenses for corrections if alterations are excessive.

## COPY

Papers should be type-written, double spaced throughout on one side of the paper and with margins of at least 3 cm (1 inch). Footnotes and elaborate tables should be avoided. Latin binomials should be underlined once to indicate italics. All other marking of copy should be left to the Editor. The original, plus at least one carbon copy, must be submitted.

## GENERAL LAY-OUT

Each paper should be headed with a concise informative **title** in capitals with the author's name below. This should be followed by the name of the institution, where the work was carried out, underlined and placed within brackets.

A concisely written **abstract** in English and Afrikaans, of not more than 200 words, should precede the text.

The subject matter should be divided into sections under short appropriate **headings** such as: INTRODUCTION, MATERIAL AND METHODS, RESULTS, DISCUSSION, CONCLUSION, ACKNOWLEDGMENTS, etc.

**Tables and illustrations** should be on separate sheets. **Figures and graphs** should be in Indian ink on white card or Bristol board. Lettering for figures can be inserted by the printers in which case authors should indicate the desired lettering on the original figure lightly in pencil. The maximum dimensions available for figures are 18 cm × 12 cm (7" × 4½"). Line drawings for blocks should be at least twice the size they will be when reduced for publication. All figures should be supplied with a scale. The most suitable method of indicating magnification is a scale line (in metric units) incorporated in the figure. Photographs for half-tone reproductions should be on glossy paper, clearly marked on the reverse side (in pencil) to indicate the top. Line drawings and half-tone illustrations are termed figures and should be numbered consecutively. Captions for figures should be typed on a separate sheet of paper.

## TAXONOMIC PAPERS

Authors must adhere to the International Rules of Botanical Nomenclature. **Abbreviations of herbaria** must be cited in accordance with the most recent edition of Index Herbariorum, Pt 1 (The Herbaria of the World, 5th ed., 1964). When **new species** are described, the exact location of type material must be indicated. When proposing **new combinations** the full citation of the basionym is required. **Indented keys** with numbered couplets are preferred when dealing with a small number of taxa. **Bracket keys** should be used when dealing with a large number of taxa. When citing **synonyms** they should be arranged chronologically into groups of nomenclatural synonyms and these should be

arranged chronologically by basionyms. Whenever possible, the types of the basionyms should be cited, e.g.:

- Bequaertiodendron magalismontanum** (Sond.) Heine & J. H. Hemsley in Kew Bull. **1960**: 307 (1960).  
*Chrysophyllum magalismontanum* Sond. in Linnaea **23**: 72 (1850). Type: Magaliesberg, Zeyher, 1849 (S, holo.; BOL!, SAM!).  
*Zeyherella magalismontana* (Sond.) Aubrév. & Pellegr. in Bull. Soc. bot. Fr. **105**: 37 (1958).  
*Pouteria magalismontana* (Sond.) A. Meeuse in Bothalia **7**: 335 (1960).  
*Chrysophyllum argyrophyllum* Hiern, Cat. Afr. Pl. Welw. **3**: 641 (1898). Syntypes: Angola, Welwitsch 4827, 4828, 4829 (BM!).  
*Boivinella argyrophylla* (Hiern) Aubrév. & Pellegr. in Bull. Soc. bot. Fr. **105**: 37 (1958).  
*Chrysophyllum wilmsii* Engl., Mon. Sapot. Afr.: 47 t. 16 (1904). Type: Transvaal, Wilms 1812 (B†, holo.; K!).  
*Boivinella wilmsii* (Engl.) Aubrév. & Pellegr. in Bull. Soc. bot. Fr. **105**: 37 (1958).

#### CITATION OF SPECIMENS

In the interests of uniformity contributors are requested to follow the recommendations of the Botanical Research Institute, Pretoria (Technical note: Gen. 4, Oct., 1967) by citing specimens according to the one degree grid system. Distribution data are given separately for each province and are arranged in the following sequences: South West Africa, Botswana, Transvaal, Orange Free State, Swaziland, Natal, Lesotho, Cape. Within each province degree squares are listed in numerical sequence, i.e., from west to east and from north to south. Whenever possible locality records should be given to within a quarter degree square. The collectors' names and numbers are underlined (printed in italics) to avoid confusion with the numbers of the degree squares, e.g.: NATAL—2829 (Harrismith): Cathedral Peak Forest Station (-CC), *Killick 1527* (PRE); . . . CAPE—3418 (Simonstown): Hottentots Holland mountains, Somerset Snееukop (-BB), Nov., *Stokoe s.n.* sub. SAM 56390 (SAM).

#### REFERENCES

These should be given in the text as follows: Jones (1968) or (Jones, 1968) or, where reference to a specific page is required, Jones (1968:57) or (Jones, 1968:57). **Literature cited** should be arranged alphabetically by surnames, chronologically within each name, with suffixes a, b, etc., to the year for more than one paper by the same author in that year. Titles of **periodicals** must be abbreviated according to the *World List of Scientific Periodicals*, 4th ed., London: Butterworth or when unable to trace the title in this list (as will be the case in taxonomic papers where abbreviations of 18th and 19th century periodicals are required) the abbreviations given in *Botanico-Periodicum-Huntianum*, Pittsburgh: Hunt Botanical Library, 1968, should be followed. Periodical titles should be underlined once (for italics). If an author is unable to determine the correct abbreviation of a journal title he is advised to type it out in full and leave its abbreviation to the editor. Titles of **books** should be underlined and given in full, together with the place of publication, name of the publisher and an indication of the edition if other than the first; e.g.:

- Davis, P. H. and Heywood, V. H., 1963. *Principles of Angiosperm Taxonomy*. Edinburgh and London: Oliver and Boyd.  
Riley, H. P., 1960. Chromosome numbers in the genus *Haworthia*. *Jl S. Afr. Bot.* **26**: 139-148.

## THE IDENTITY OF *ALOE VITUENSIS* BAKER

L. C. LEACH

### ABSTRACT

The identity of *Aloe vituensis* Baker from Kenya is discussed and an amplified description, based on plants from the Tana River area, is given, together with notes concerning the collector Thomas and the Denhardt brothers' Tana Expedition of 1878.

### UITTREKSEL

DIE IDENTITEIT VAN *ALOE VITUENSIS* BAKER. Die identiteit van *Aloe vituensis* Baker uit Kenya word bespreek en 'n verbeterde beskrywing gebaseer op plante uit die Tanarivier omgewing word gegee asook aantekeninge oor die besoek van die versamelaar Thomas en die Denhardt broers se Tana ekspedisie van 1878.

### INTRODUCTION

Some years ago Col.<sup>R.D.</sup> Bayliss gave me a cutting from an *Aloe* collected at Hola in the Tana River area of Kenya. This proved to be "difficult" in cultivation (Plants collected at the same locality by Messrs. P. R. O. Bally and G. Classen, did not apparently survive, nor did those retained by Col. Bayliss in Mombasa) and did not flower while in cultivation at Salisbury, Rhodesia, but eventually did so when transplanted to Nelspruit, S. Africa.

At that time it was thought to be an undescribed species and I was most pleased to find, among the unidentified specimens in the National Herbarium, Pretoria, another gathering from Moyale which appeared to be identical with the Hola plant.

It was at this stage that it was considered to be advisable to check on any "species non satis cognitae" from the same region. The possibility was then disclosed that our plant might be the long lost *Aloe vituensis* Baker. Fortunately the type specimen of this species is one of those which escaped destruction in Berlin and examination of this material confirmed that the Hola and Moyale specimens were both conspecific.

*Aloe vituensis* Baker in Fl. Trop. Afr. 7: 458 (1898).—Berger in Engl. Pflanzenr.: 261 (1908).—Reynolds, Aloes Trop. Afr. Madag.: 529 (1966).

Type: Kenya, Thomas 113 (B!).

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Accepted for publication 7th November, 1969.

**Kenya: K1**, Moyale, Buna road, alt. c.2500 ft., "especially but not exclusively on termite mounds", *Gillett* 13660 (EA; K; PRE), (duplicates of this number are known to be at EA and K but I have not seen them); **K7**, Massa (Masabubu ?), Tana River, fl. 31.iii.1896, *Thomas* 113 (B); Hola, Tana Riv., comm. *Bayliss*, cult. Nelspruit, fl. 7.v.1967 and 21.vi.1968, *Leach* 899 (B; K).

Note: Massa is shewn on the map of Dr. Fischer's journeys, in Petermann's *Geogr. Mitteilungen*, t. 19 (1886), as being the turning point of the Denhardt brothers' 1878 expedition. Its position on the Tana River appears to have coincided closely with that of the present day Masabubu at 1° 13' S: 40° 00' E, about 8 miles south of Bura.

Native name: "ASSAI" (*Thomas*); "HARGEISA BaRICha" (Boran) (*Gillett*).

A description based on plants collected at Hola and cultivated at Nelspruit now follows:—

*Plant* a very sparingly branched shrublet, branched from the base, with slender stems up to 40 cm long; stems at first erect, becoming more or less decumbent, with the apical portion ( $\pm$  15 cm) erect, generally foliate for 15 to 20 cm. *Leaves* very narrowly ovate attenuate, up to 27 cm  $\times$  3 cm (37.5 cm  $\times$  3 cm *Gillett* 13660), relatively thick (up to 12 mm) and fleshy, generally biconvex, laxly spirally arranged low down, becoming crowded at the apex, basally sheathing, with the sheaths brown striatulate and the internodes up to 3 cm long; *upper surface* slightly concave, flat, or usually convex, becoming slightly canaliculate towards the apex, yellow-green below, becoming bronze to brown towards the margins and apex (apparently eventually wholly brown), obscurely striatulate, with numerous lenticular or somewhat H-shaped whitish spots; *lower surface* paler, with more numerous whitish markings, more convex than the upper, rather sharply compressed into the thin acute margins; *margin* whitish, narrow, sinuate dentate or the interspaces straight; *teeth* pungent, deltoid or uncinat, orange-brown, 3—4 mm long, 5—10 mm apart. *Inflorescence* simple, strictly erect, about 50—60 cm long. *Peduncle* about 45 cm long, very slender, terete, only very slightly compressed low down,  $\pm$  5 mm diam. with the angles acute, sometimes very narrowly wing-like, devoid of any bloom, obscurely brownish sulcate-striatulate, green becoming brownish above (pale straw-coloured when dry), with a few widely spaced sterile bracts for about half its length. *Raceme* subdensely flowered, cylindric, slightly acuminate, 7—8 cm long (lengthening in fruit to  $\pm$  15 cm, *Gillett* 13660),  $\pm$  6 cm diam.; buds green tipped, suberect, open flowers nutant. *Bracts* broadly ovate acute, usually with a small tooth on one, or occasionally on both sides,  $\pm$  7—9 mm long, up to 6 mm wide, appearing to be fleshy from being markedly convex (initially quite concealing the pedicels), pale greenish yellow to whitish buff, with 7—9,



initially green, becoming brown to blackish nerves and a thin whitish margin; the sterile bracts many nerved, less markedly convex and somewhat larger, the lowest  $\pm 14$  mm  $\times$  10 mm. *Pedice*l 4—7 mm long (lengthening in fruit to  $\pm 10$  mm), pale green to pale dull yellow with a few minute white flecks. *Perianth* slightly curved, basally obtuse and shortly stipitate, the base and stipe minutely tuberculate-asperate, 27—29 mm long,  $\pm 5$  mm diam. towards the base, gradually slightly contracting above the ovary, thence gradually trigonously expanding to the wide open mouth, 8—10 mm diam.; *outer segments* free 6—8 mm (up to 12 mm, *Gillett* 13660), obscurely 5—7 nerved; nerves orange-brown, becoming confluent and darker towards the slightly spreading whitish apex; *inner segments* themselves free but dorsally adnate to the outer for  $\pm 20$  mm, more obtuse and more spreading than the outer, with wider translucent whitish margins and three more prominent, darker nerves forming a slight keel. *Filaments* filiform flattened, translucent pinkish white, the three inner narrower and lengthening before the three outer; *anthers* rich orange-brown with pale peach-coloured pollen, crowded towards the lower part of the mouth, not or shortly (up to 4 mm) in turn exserted. *Ovary*  $\pm 4.5$  mm  $\times$  2.25 mm, 6-grooved, with the sutures more deeply grooved than the angles, pale green, faintly peach-coloured in the grooves; *style* pale green, paler at the base; *stigma* white, not or very shortly exserted (up to 1 mm). *Capsule* (almost ripe) green, smooth, ellipsoid,  $\pm 20$  mm  $\times$  10 mm diam. (when dry, pale fawn-coloured, transversely rugulose, 16 mm  $\times$  8 mm, *Gillett* 13660), shortly stipitate, the stipe minutely tuberculate-asperate; *seeds* more or less irregularly trigonous, with a broad, translucent, whitish, fragile wing at each end, which enlarges laterally below the seed to form a smaller wing set centrally at an angle to the main portions.

*A. vituensis* appears, in many respects, to be most closely related to an as

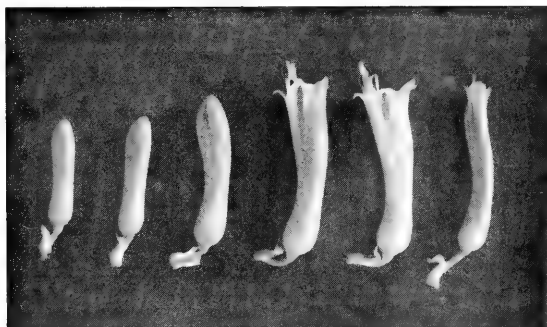
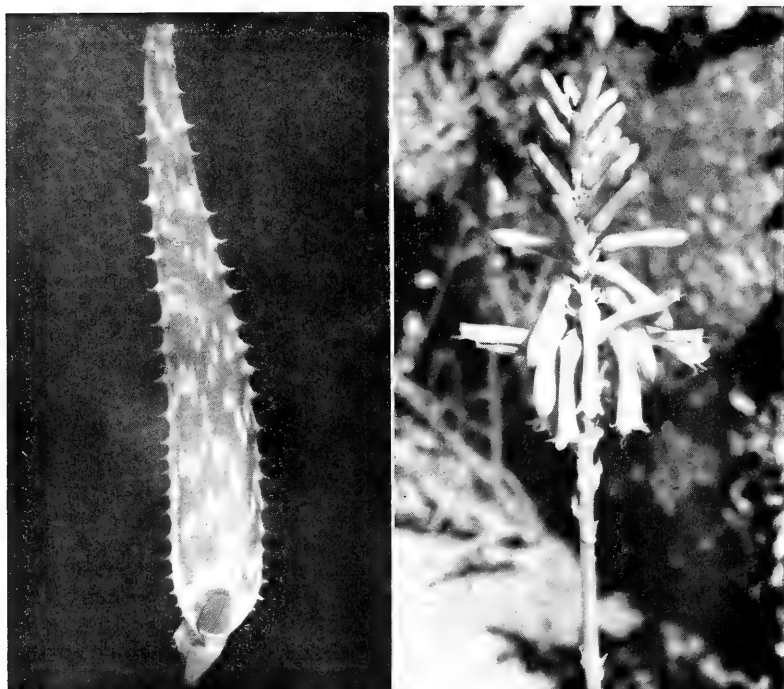


FIG. 1. *A. vituensis* Bak. Flowers 1/1 from a plant from Hola, cult. at Nelspruit

FIG. 2. *A. vituensis* Bak.

Leaf and raceme from a plant cultivated at Nelspruit, Leach 899

yet undescribed species from Mossuril Bay in northern Moçambique. This has also proved to be "difficult" in cultivation so that material adequate for its description has, unfortunately, not yet been obtained. Of the known species it seems to be most closely related to *A. dorotheae* Berger from Tanzania but is distinguished by its taller, more densely flowered inflorescence, its caulescent, laxly foliate stems and proportionally longer narrower leaves. However, plants do not fit well into Reynolds's Group 5 (*Aloes Trop. Afr. Madag.* 1966) by reason of their stems and habit. In habit, laxly foliate slender stems and turgid narrow leaves, this attractive species is perhaps closest to *A. confusa* Engler (Group 10) from Lake Chala in Tanzania, but in most other respects it is quite distinct. In dried material the nerves of the perianth become very conspicuous so that our species would appear to fit into Reynolds's Group 4 (Small plants with striped flowers). However, in the live state no trace of stripes is evident,

and plants appear, therefore, to fit best into Group 19A (Low undershrubs) being keyed out by:— "*Inflorescence simple, 60 cm high*"

The collector's label on the type sheet gives the interesting information "Aloe, gifling, disnt zum vergiflen van Krokodilen". Whether this modest plant is really effective in disposing of so redoubtable a reptile is not known, but the note has certainly given pause to the present writer in his habit of testing by taste for the presence or absence of the bitter principle in the leaf sap of the genus.

There is also, on the same label, an apparent discrepancy in dates: the heading being "G. Denhardt's Tana Exped. 1878, Thomas (Gebr. Denhardt)" while the date of the gathering is given as "31 März 1896". This prompted some enquiry into the history of Thomas and the brothers Denhardt, and I am much indebted to Dr. Edith Raadts of the Botanisches Museum, Berlin, for much of the information which now follows.

Little is known about Thomas except that his collections were presented to the Berlin Museum by Gebr. Denhardt; Urban in *Geschichte des Botanischen Museums 1815—1913* (1916), lists these as:— Samml. I: Wituland (Gebr.

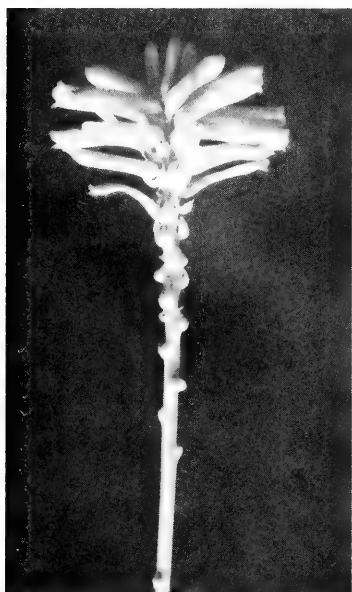


FIG. 3. Raceme shewing strongly convex bracts, cult. Nelspruit



FIG. 4. The specimen from Moyale, Gillett 13660, in the National Herbarium, Pretoria

Clemens und Gustav Denhardt's Tana Exped. a. 1896) 219 Nr. Samml. II: Mombasa and Takaunga (a. 1897) 93 Nr. Samml. III: Nairobi (a. 1903) 137 Nr.

Denhardt, G. & C., Berlin are listed in Schnee, Deutsches Kolonial Lexikon **1**: 293 (1920), as exporters of mangroves from G.E.A. with stations at Tanga, Pangani, Lindi and Kilwa. From further personal notes in the same publication and in Weidmann, *Deutsche Männer in Afrika*: 28 (1894), it appears that the firm obtained a land concession from the Sultan of Witu, a portion of which was disposed of to the Witu Association and the remainder used for plantations, which use appears to have continued for a period, under the management of German staff, after the area had come under British jurisdiction in 1890. Clemens Denhardt had, in the meantime, engaged in several E. African exploratory expeditions; his brother Gustav having returned to Germany, because of ill health, soon after their Tana expedition. On this latter journey the two brothers accompanied Dr. Fischer, starting at the Osi River on the coast they proceeded via Kau and Belesoni to the Tana River, which they followed to as far north as Massa, in the Malakoti(e) land, whence they started the return journey in November 1878.

It seems possible therefore, that Thomas was employed by Gebr. Denhardt & Co. on their Witu plantations (or his expeditions financed by them) and that when he duplicated the 1878 Tana Expedition his gatherings were included under the original heading although it seems improbable that either of the brothers actually took part in this second expedition.

#### ACKNOWLEDGEMENTS

The author is much indebted to and wishes to thank:

Messrs. P. R. O. Bally, R. D. Bayliss, Geo. Classen and J. Marnier-Lapostolle for live plants of *Aloe* from the N.F.P. and Tana Riv. area of Kenya.

The Director, Botanischer Museum, Berlin, for the loan of the type specimen of *A. vituensis* and for photo copies of several pages from the literature relating to Gebr. Denhardt and the collector Thomas.

Dr. L. E. Codd, Chief, Botanical Research Institute, Pretoria and Mr. R. B. Drummond, Chief Botanist, Government Herbarium, Salisbury, for the facilities of their respective herbaria and Mr. Th. Müller for his help with German translations.

Mr. J. B. Gillett of the East African Herbarium, Nairobi, for extensive notes concerning several of his gatherings of *Aloe* in N.F.P., Kenya, and a photograph of one of these.

The Director, Royal Botanic Gardens, Kew, and Mrs. D. Polhill of that Institute for a photo copy of the map of Dr. Fischer's journeys and other relative information.

## CULTURE OF HAWORTHIA INFLORESCENCES IN VITRO

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### ABSTRACT

Leafy shoots, roots and callus are induced from the flower axes on inflorescences of four species of *Haworthia* when inflorescences are implanted in White's basal medium supplemented with indole acetic acid (IAA), coconut milk (CM) and kinetin. The callus subsequently differentiated into shoots and roots in this medium. A combination of IAA, CM and kinetin is essential for the production of vegetative buds and callus from the flower axis. On subculturing, the callus did not grow in White's medium alone but on supplementing it with IAA or CM or kinetin the callus differentiated into many plantlets. The addition of kinetin to the medium, however, greatly increased the production of leafy shoots but suppressed root formation.

### INTRODUCTION

In recent years the artificial production of plantlets from isolated roots, stems, and floral primordia has been demonstrated (Danckwardt-Lilliestrom, 1957; Sastri, 1962; Konar and Nataraja, 1964). However, very little is known about the growth potentiality of flower axes in culture. With this in mind, tissue culture work with *Haworthia* inflorescences was started at the University of Kentucky and a partial success of this study was presented at the annual meeting of the Botanical Society of America (Majumdar and Sabharwal, 1968). This investigation was continued further by the author at the Arkansas Polytechnic College. The present report is the detailed account of the results obtained from the experiments with the inflorescences of several species of *Haworthia* grown on a variety of media.

### MATERIAL AND METHOD

*Haworthia* plants were provided by Dr. Herbert P. Riley of the University of Kentucky who obtained them from South Africa and the International Succulent Institute in California. Successful results are obtained with four plants—*H. variegata*, small form; *H. chlorocantha*; *H. turgida* var. *pallidifolia* and *H. retusa*. The inflorescences were surface sterilized in chlorine water, washed in sterile distilled water and planted on a White's basal medium containing sucrose (2 per cent) + indole acetic acid (IAA, 1 mg/litre) + kinetin (0.5 mg/litre) + coconut milk (CM, 20%) + vitamins (pyridoxine hydro-

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Accepted for publication 12th November, 1969.

chloride 0.1 mg/litre, nicotinic acid 0.5 mg/litre and aneurin hydrochloride 0.1 mg/litre).

Later inflorescences were inoculated on the following media: (a) White's basal medium with two per cent sucrose (WB) + vitamins; (b) WB + 1AA; (c) WB + CM; (d) WB + kinetin; (e) WB + 1AA + CM; (f) WB + 1AA + kinetin; (g) WB + CM + kinetin; (h) WB + 1AA + CM + kinetin. Ten cultures were made for each treatment and each experiment was repeated twice.

The medium was jelled with 0.8 per cent Difco bactoagar; its pH was adjusted to 5.8, and the cultures were kept at  $26^{\circ} \pm 1^{\circ}\text{C}$ .

#### OBSERVATIONS AND DISCUSSION

Inflorescences did not show any response and dried when inoculated in (a), (b), (c) and (d) media. The presence of 1AA + CM or 1AA + kinetin in



FIG. 1. *H. retusa* inflorescence showing formation of vegetative buds; note the dried flowers at the upper portion of the inflorescence, X4.

FIG. 2. *H. chlorocantha* with spiny leaves which arose from the flower axes on inflorescence, X4.



FIG. 3. *H. turgida* var. *pollidifolia* inflorescence showing callus formation from flower axis, also note the production of leafy buds and root from flower axes, X4.

FIG. 4. *H. variegata* small form, showing the differentiation of callus tissue into leafy shoots and roots (arrows), note the matured leaves which arose from a flower axis of the inflorescence, X4.

White's basic medium did not have any effect. Some response was observed when kinetin was added in the presence of coconut milk. In this medium few inflorescences produced vegetative buds from some flower axes. Very good response was observed when White's basic medium was supplemented with 1AA + kinetin + CM. In most instances the flowers on the inflorescences became dry and in about 25—30 days vegetative buds were seen to appear from some flower axes (Fig. 1). Within a few days the buds developed into leaves with spiny margins (Fig. 2) and looked like plantlets. After the formation of the leafy shoots an occasionally healthy root was found to emerge from the flower axis (Fig. 3). White callus formation was noticed almost simultaneously from flower axes of some inflorescences touching the medium (Fig. 3). At the beginning the callus growth was rapid and in about 15—20 days it differentiated into many plantlets with shoots and roots (Fig. 4). It can be seen from the figures that no healthy vegetative buds are present in the flower axes of the apical region of the inflorescences, but active growth is noticed in the lateral buds of flower axes. The lateral shoot initiation may be due to the lack of influence of apical dominance.

On subculturing, the callus differentiated into shoots and roots on all media except in WB + vitamin. However, the presence of kinetin greatly increased the production and growth of the plantlets but suppressed rooting. Many plantlets from culture tubes have been successfully transferred to soil.

Frequently flower buds of *H. variegata* grew into mature flowers or produced fasciated flowers from flower axes; a detailed account of flower bud development in *Haworthia* will be reported elsewhere (Majumdar, 1969).

It is seen that induction of vegetative buds and formation of callus from the flower axes of *Haworthia* and callus differentiation are possible when 1AA, CM and kinetin are added to the White's basal medium. However, none of the above substances alone is effective in producing vegetative buds or callus and differentiation of the callus. The absence of vitamin did not have any adverse effect on the formation of buds and callus and callus differentiation.

It is observed in subculture experiments that any one of the above mentioned chemicals (1AA, CM, kinetin) can differentiate the callus into leafy shoots with few roots. Kinetin was not indispensable for the differentiation of callus, but its presence no doubt increased the rate of the expression of the shoot morphogenesis.

This study, thus, demonstrates for the first time that the cells of the flower axis of *Haworthia* have the potentiality to produce leafy shoots and roots; and callus from the flower axis can undergo developmental sequence to reconstitute new plants.



## UITTREKSEL

DIE KWEEK VAN *HAWORTHIA* BLOEIWYSIES IN VITRO. Steggies met blare, wortels en kallus weefsel word verkry van die blomstele uit die bloeiwyses van vier soorte *Haworthia* waar die bloeiwyses in White se basale medium, aangevul met indolasynsuur (IAA), kokosneut melk (CM) en kinetien, ingeplant is. Die kallus het in hierdie medium differensieer in stingels en wortels. 'n Kombinase van IAA, CM en kinetien is essensieel vir die ontwikkeling van vegetatiewe knoppe en kallus van die blomsteel. In 'n sub-kultuur het die kallus nie in White se medium alleen ontwikkel nie maar met die byvoeging van IAA en CM of kinetien het dit in 'n menigte klein plantjies differensieer. Kinetien het egter 'n groot produksie van blaarryke stingels en 'n onderdrukte wortel vorming veroorsaak.

## ACKNOWLEDGEMENT

I thank Dr. P. S. Sabharwal of the University of Kentucky for the laboratory facilities. I am grateful to Professor Herbert P. Riley of the same institute for helpful criticisms.

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## CHROMOSOME NUMBERS OF WEST AFRICAN ALOES

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### ABSTRACT

Chromosome counts are reported for the four taxa in the genus *Aloe* occurring in West Tropical Africa, and for one related taxon from Uganda. In all cases the somatic number was found to be  $2n=14$ .

### UITTREKSEL

CHROMOSOME GETALLE VAN WES-AFRIKAANSE ALOES. Chromosoom tellings vir vier taxa van die geslag *Aloe* wat in Wes-Tropiese-Afrika voorkom asook een verwante taxon van Uganda. In alle gevalle was die somatiese chromosoom getal  $2n=14$ .

Previous work has shown that the genus *Aloe* is quite uniform cytologically. Apart from the polyploid *A. ciliaris* Haw. and certain irregularities reported in plants of *A. vera* L. (Vig, 1968) and some other species (Sharma & Mallick, 1965), all species examined so far have a somatic chromosome number of  $2n=14$ . In common with other members of the tribe *Aloineae* they have a characteristic diploid karyotype of eight long chromosomes and six short chromosomes (Fig. 1). Fewer than half of the species in this genus are native to South Africa, but almost all of the species examined cytologically are South African (Riley, 1959).

Four indigenous taxa are known in the area of the "Flora of West Tropical Africa" (Keay, 1968). Chromosome counts were obtained from collections of these as a preliminary to some experimental biosystematic studies. An exotic variety of one of these species, originally collected in Uganda, was also examined. Counts were obtained from root-tip preparations pretreated in 8-hydroxyquinoline, fixed in acetic alcohol, hydrolysed in HCl and squashed in acetocarmine. At least ten counts were obtained for each collection. Voucher specimens with the writer's collection numbers (Table 1) are in Kumasi University Herbarium (KUM), Ghana, and clonal replicates are to be deposited in Kew Herbarium (K), England and Legon University Herbarium (GC), Ghana. Specimens of *Reynolds* 6724 are in K and PRE (Reynolds, 1966).

Results are shown in Table 2. All the material examined was found to have the same chromosome number as the majority of previously examined species,

TABLE 1  
Provenance of material examined

Collection number	Locality
	<i>A. buettneri</i> Berger
481	Kintampo, N. Ghana.
483	Sagadugu, N. Ghana.
484	Karamenga, N. Ghana.
485	Walewale, N. Ghana.
486	Tamale, N. Ghana.
497	Gushie, N. Ghana.
506	Funtua, N. Nigeria.
507	Zaria, N. Nigeria.
530	Batia, Atakora Mts., N. Dahomey.
	<i>A. keayi</i> Reynolds
171	<sup>1</sup> Oduponkpehe, Accra Plains, S. Ghana. (Type locality)
	<i>A. macrocarpa</i> Todaro var. <i>major</i> Berger
482	Nakpanduri, N. Ghana. <sup>2</sup>
516	Vom, Jos Plateau, N. Nigeria.
	<i>A. schweinfurthii</i> Baker var. <i>schweinfurthii</i>
487	Botianaw, Accra Plains, S. Ghana.
501	Otoase, nr. Nsawam, S. Ghana.
503	Savé, C. Dahomey. <sup>3</sup>
519	Jos, N. Nigeria.
522	Bauchi, N. Nigeria.
529	Tanguiéta, Atakora Mts., N. Dahomey. <sup>3</sup>
	<i>A. schweinfurthii</i> Baker var. <i>labworana</i> Reynolds
Reynolds 6724	Loyorot, Labwor Hills, Uganda.

## NOTES:

1. Correct spelling according to the Ghana Survey Department; Keay and Adams' spelling 'Odupoukpeehe', adopted by Reynolds, is presumably either an error or a vernacular variant.
2. New record for Ghana.
3. New record for Dahomey.

TABLE 2  
Somatic chromosome counts

Taxon	No. of clones examined	2n=
<i>A. buettneri</i> Bgr. . . . .	9	14
<i>A. keayi</i> Reyn. . . . .	1	14
<i>A. macrocarpa</i> Tod. var. <i>major</i> Bgr. . . . .	2	14
<i>A. schweinfurthii</i> Bak. var. <i>schweinfurthii</i> . . . . .	6	14
<i>A. schweinfurthii</i> Bak. var. <i>labworana</i> Reyn. . . . .	1	14

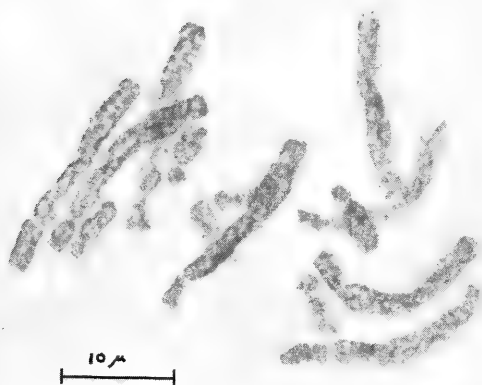


FIG. 1. Metaphase in root tip of *Aloe buettneri* (Newton 486)

viz.  $2n=14$ . Although ten or more counts were obtained from each plant, no irregularities of the kind reported by Vig and by Sharma and Mallick were observed. According to Reynolds (1966) *A. buettneri* has the greatest geographical range of any species in this genus, extending over 3,500 miles. It is interesting to note that unlike many temperate plants, this species does not owe its extensive distribution to polyploidy.

#### ACKNOWLEDGEMENT

The writer is grateful to Mr. L. C. Leach, of Nelspruit, E. Transvaal, for living material of *Reynolds* 6724.

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## STUDIES IN THE XYLARIACEAE: VIII. XYLARIA AND ITS ALLIES

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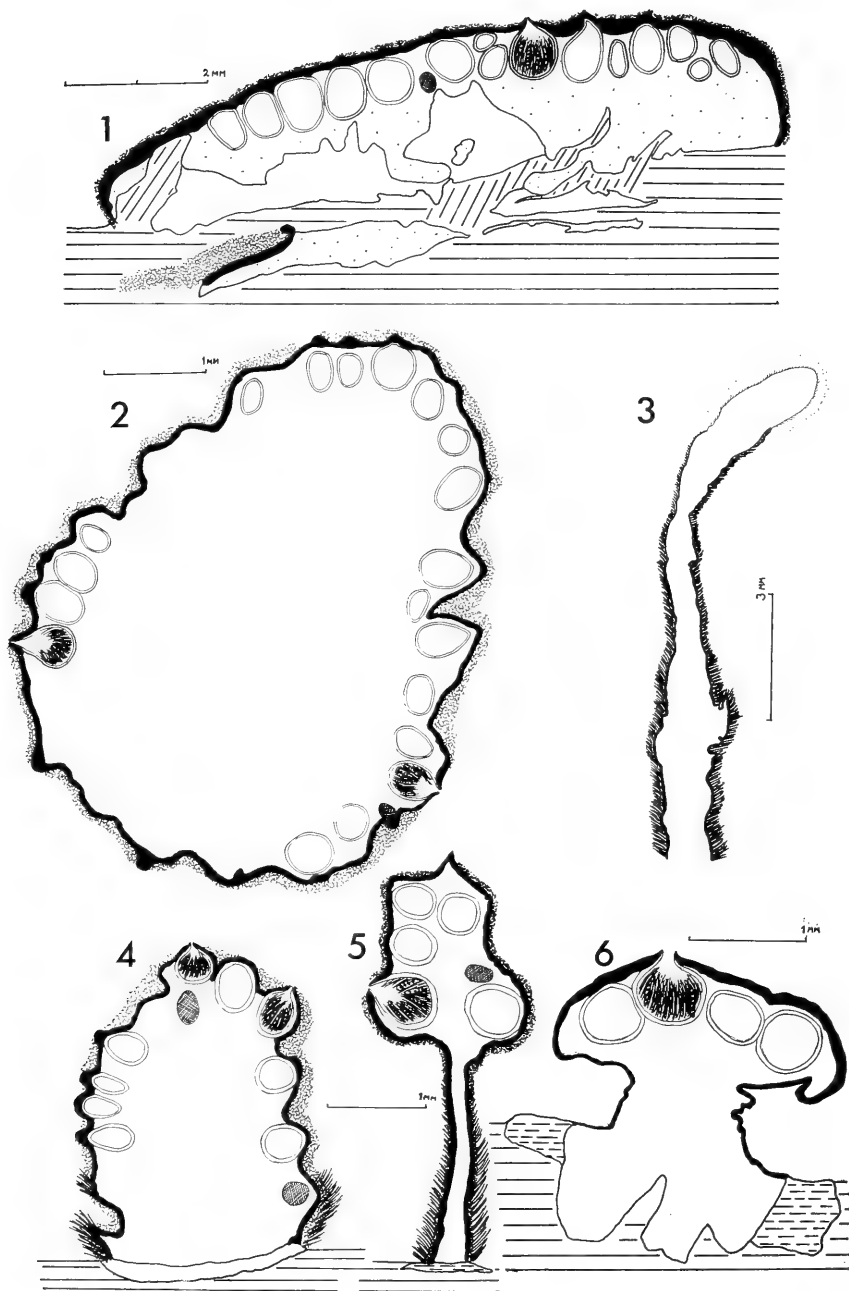
The so-called “fleshy” genera of the Xylariaceae, characterized by a white interior, are actually the most poorly defined of the family, yet they include some of its oldest known representatives. In structure they are uniform and fairly specialized, but the extreme range in morphology has led to considerable confusion of specific limits and interrelationships.

The most important and hitherto little emphasized taxonomic character is probably the development of the ectostroma. This is present in the majority of species as a continuous or scabrous, smooth or verrucose crust of dark anastomosing mycelium, soft in texture and varying from white or yellow to dark brown at maturity. Varitchak (1931) and Brown (1913) in their studies of stromal development make only passing reference to it. Saccardo referred to a shaggy (*hordellus*) outer layer in many of his descriptions of *Xylaria* throughout the Sylloge Fungorum but did not comment further. Miller (1942, p. 262) referred to a “pellicle” or crust visible as plaques or linear strips, but apparently did not compare it directly with any structure in *Hypoxylon*. The development of the ectostroma, which is corky in nature, runs concurrently with that of conidia at the distal end of the stroma and/or a subiculum of dark felty hyphae at the base.

The number of species in which the ectostroma truly cannot be recognized is small and the degree of affinity between them not well known. In some of these species, also, the outer crust formed from the entostroma remains soft instead of becoming rigid and “carbonaceous”. The entostroma is, however, characteristically divided into rigid outer crust enclosing the perithecial apices and a soft or fleshy interior beneath the perithecia. No separation occurs between the two. The centre tissue is usually pure white but may be cream, dull yellow or even grey, and it varies in like manner from solid to hollow or involute.

The ascal plugs are cubic to rectangular and usually very prominent on staining with iodine. The only other groups to have this character are *Hypoxylon* sect. *Entoleuca* and *Anthostomella*. (See Plate III:1).

The classical disposition of the genera is as follows:





**Kretzschmaria** Fries E. M. Summa Vegetabilium Scandinaviae 409, (1849).

Unfortunately there is no easy distinction between the less specialized members of the genus and the "carbonaceous" series of *Hypoxyton* and *Rosellinia* described previously under the section Entoleuca. Attempts to define these intermediates have resulted in the establishment of at least 4 genera, *Kretzschmaria* Fries (1849), *Sarcoxyton* Cooke (1883), *Penzigia* Saccardo (1888, 1892), and *Ustulina* Tulasne (1863).

If a major taxon should be constituted to embrace one or more unique trends of specialization, then the writer believes that *Kretzschmaria* alone deserves retention. If, on the other hand, it is admissible to regard a genus as a "catch-all" for species of vague affinity, then one might view all these genera as acceptable. *Kretzschmaria* is distinct from *Xylaria* chiefly in that all the perithecia are vertically oriented, and in addition many accepted species of *Kretzschmaria* are characterized by the excentric development of the growing axis which becomes an umbonate or aristate sterile apex on one side of the fertile clava. The type species, *K. clavus* Fr., does not show this peculiarity, but is otherwise clearly related on account of the flattened obconic nature of the clava.

**Ustulina** Tulasne L. & P. Selecta Fung. Carpol. 2, 23, (1863).

This genus was based on *U. vulgaris* (*Hypoxyton ustulatum* Bulliard), taking into consideration the extensive superficial aplanate form of the stroma and the fleshy nature of the entostroma. The writer agrees with Miller (1961 p. 2) that the genus lacks clear definition, but feels that the species have greater affinity to the Xylariaceous series of genera and to *Kretzschmaria* in particular, rather than to *Hypoxyton* section Entoleuca where they were placed by Miller.

Other species of *Kretzschmaria* are subglobose in form though still stipitate, and these can hardly be separated from those in *Penzigia* which at present includes species of considerable range of form: some with a definite stipe, others sessile and attached at a narrow point only, and others with clavata varying

FIGURE I. Stromal Structure, diagrammatic

Vertical lines and dots: Conidiophores and conidia  
 Irregular lines: Dark crustose mycelium (ectostroma)  
 Straight lines: Setose or subiculate hyphae  
 Solid black: Carbonaceous entostroma  
 White, black or dotted: Fleshy entostroma  
 Horizontal lines: Wood  
 Interrupted lines: Fungal invasion of wood

All are vertical sections except (2); Horizontal

1. *Xylaria berteri*: Penzigoid stroma
2. *Xylaria leprosa*: Typical *Xylaria* stroma
3. *Xylaria fioriana*: Coremium
4. *Xylaria fioriana*: Penzigoid stroma
5. *Xylaria apiculata*: Stroma clearly differentiated into stipe and clava
6. *Podosordaria plumosa*: Stroma without apparent ectostroma

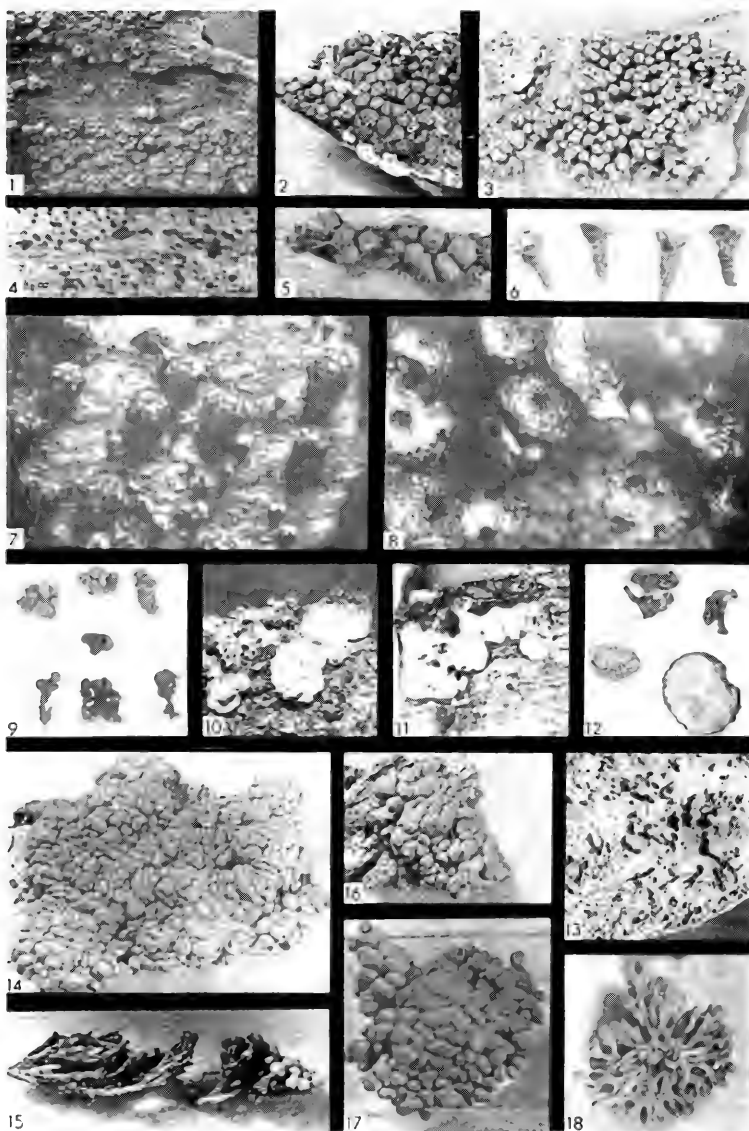
from pulvinate to cylindric. *Penzigia*, though likely established by Saccardo to accommodate such awkward species, was not given precise definition. The generic description runs: "...stroma subglobosum vel hemisphaericum vel obpyriforme, intus plerumque radiatofibrosum (numquam concentrice zonatum) extus crustaceolaccatum (pallens), lebe; perithecia stromate omnino immersa, collis brevibus vel subnullis; ostiola punctiformia non extantia...". The precise definition of *Penzigia* has always been in doubt, notwithstanding Petch's attempts (1924, p. 138). Miller assigned several species to it in which there is a clear white basal tissue, but did not apparently give consideration to many others in the section *Entoleuca* of *Hypoxylon* described earlier where the situation is identical, or where the entostroma is not heavily discoloured.

**Sarcoxylon** Cooke, based originally on the single species *S. compunctum* (Jungh) Cooke, could not be distinguished from *Penzigia*. However, Cooke and others confused the issue by adding further species to *Sarcoxylon* that properly belonged to *Entonaema*. Of these, *S. aurantiaca* Pat. is synonymous with *E. liquescens* Möller, while the other four, *S. spathulatum* (B. & Br.) Petch, *S. lycogaloides* (B. & Br.) Cke., *S. deightoni* Petrak, and *S. lerati* (Henn.) Lloyd are still not sufficiently known, and the writer has not examined any specimens. The type species *S. compunctum*, is now *Xylaria compuncta* (Jungh) Berk., where it is correctly placed.

The writer proposes to combine part of *Penzigia* with *Kretzschmaria* and part with *Xylaria*, based primarily on the orientation of the perithecia. All stipitate or sessile species of *Penzigia* in which the clavata or clavulae vary

PLATE I. Stromata

1. *Kretzschmaria frustulosa* × (0·6)
2. *Kretzschmaria heliscus* × (0·6)
3. *Kretzschmaria novo-guineensis* × (0·6)
4. *Kretzschmaria (Stilbohypoxyton) rehmi* × (0·6)
5. *Kretzschmaria aggregata* × (1·6)
6. *Kretzschmaria tuckeri* × (1·6)
7. *Kretzschmaria rehmi*: Excentric sterile apices and uniperitheciate stromata × (6)
8. *Kretzschmaria novoguineensis*: Excentric apices and multiperitheciate stromata × (6)
9. *Kretzschmaria verrucosa* × (0·4)
- 10—13. *Kretzschmaria deusta* × (0·4)
  10. Early conidial stage
  11. Later stage with developing perithecia
  12. Mature stage: Views of superficial stromal crust and part of branching system beneath substrate
  13. Part of the branching system on wood after bark has been removed
14. *Kretzschmaria lichenoides* × (0·6)
15. *Kretzschmaria cetrarioides* × (0·6)
16. *Kretzschmaria coenopus* × (0·6)
- 17—18. *Kretzschmaria xylarioides*: Surface and reverse views of stromata to show branching habit × (0·6)



from pulvinate to obconic instead of globose or cylindrical, the perithecia are vertically oriented instead of horizontally, and the sterile apices of stromata if present are excentric, are placed in *Kretzschmaria*. The basal tissue in these species is soft and corky, rarely rigid (i.e. resistant to the point of a needle) and pure white or discoloured brown. Those species of *Penzigia* in which the stroma is white and rigid and many of the perithecia are lateral as well as vertical, (including the type species *P. compuncta* (Jungh) Sacc. & Paol., *Penzigia cretacea* (B. & Br.) Sacc. & Paol. and *P. dealbata* (Berk & Curt.) Sacc. & Paol., and others, *P. berteri* (Mont.) Mill. and *P. enteroleuca* (Speg.) Miller), are disposed here under *Xylaria*, ignoring the broad differences in stromal shape.

The subsessile species, *P. discolor* (B. & Br.) Miller, *P. bermudensis* Miller, *P. citrina* (Shear) Miller and their relatives were placed in *Hypoxylon* section Entoleuca (Martin 1967) because of general similarity, including the ability to form uniperitheciate stromata with the perithecia evident in outline. They are obviously transitional between *Hypoxylon* and *Kretzschmaria*.

One additional subsessile species, *Hypoxylon cyclopicum* Spegazzini, formerly placed in Miller's section Primocinerea of *Hypoxylon*, is considered to be a true *Kretzschmaria*.

Finally, there is the small genus *Stilbohypoxyton* Hennings (1902). The type, *S. mölleri* Henn. is based on an immature specimen, but both this species and *S. rehmsii* Theissen (1908) with which it is probably synonymous, are distinguished by the excentric position of the growing apices with respect to the fertile portion. This relates the species to the *Kretzschmaria* series, while the coremioid nature of the apex, which may also bear conidia, is typical of *Xylaria* as well. The small number of perithecia (1—2) and their sharp outline, however, is characteristic of *Hypoxylon*. The writer prefers to place this taxon as a section of *Kretzschmaria*.

#### KEY TO THE SPECIES

- 1     Stromata uni— or biperitheciate, with ovoid or pulvinate fertile portion bearing a distinct excentric ochraceous umbo that may bear conidia when young; ectostroma in plaques, yellowish-green; entostroma divided into outer black crust and inner white corky basal portion; perithecia evident in outline; spores gibbous to navicular, narrow ended, medium brown,  $6.5 \times 15.5 \mu$   
       Section *Stilbohypoxyton* Hennings  
       *Kretzschmaria rehmsii* (Theissen) Martin (Plate I:4, 6)  
       syn. *Stilbohypoxyton rehmsii* Theissen  
       ? syn. *Stilbohypoxyton moelleri* Hennings
- 1'    Stromata simple or branched, clavate or clavulae with few or several perithecia but always immersed and not clearly evident in outline; growing apices when visible at maturity always excentric; ectostroma continuous or in plaques; entostroma divided into outer black crust and inner white or discoloured corky basal portion  
       section *Eukretzschmaria* Martin . . . . . 2
- 2     Stromata with distinct stipes above substrate or with excentric sterile apices; clavata not aplanate . . . . . 8

- 2' Stromata attached at a central point only, or rarely by a broad base; apex fertile if developed; clavata sometimes aplanate with ramifying stroma beneath substrate.....3
- 3 Spores with spiral germ slits, navicular, narrow-ended, medium brown,  $11.0 \times 32.5\mu$ ; stromata pulvinate; ectostroma in plaques, dull brown  
*Kretzschmaria atosphaerica* (Masse) Martin  
 syn. *Penzigia atosphaerica* (Masse) Miller
- 3' Germ slits straight or rarely undulating.....4
- 4 Stromata pulvinate, not more than 10 mms. diam.....5
- 4' Stromata aplanopulvinate or aplanate, or globose-cylindric, of large size.....6
- 5 Spores equilateral, oval, broad ended, amber,  $2.5 \times 5.0\mu$   
*Kretzschmaria frustulosa* (B. & C.) Martin (Plate I:1)  
 syn. *Penzigia frustulosa* (B. & C.) Miller
- 5' Spores gibbous, narrow-ended, dark brown,  $13.0 \times 28.0\mu$   
*Kretzschmaria arntzenii* (Theiss.) Montagne  
 syn. *Penzigia arntzenii* (Theissen)
- 5'' Spores crescentic, narrow-ended, dark brown,  $6.0 \times 17.0\mu$ ; germ slits linear  
*Kretzschmaria turbinata* (E. & E.) Martin  
 syn. *Poronia turbinata* Ellis & Everhart
- 6 Stromata predominantly pulvinate, or globose-cylindric, with verrucous surface; ectostroma in clear dark brown plaques; spores gibbous, with narrow or beaked ends, dark brown,  $10.0 \times 40.0\mu$   
*Kretzschmaria verrucosa* (Mill.) Martin (Plate I:9)
- 6' Stromata predominantly aplanate, ectostroma continuous.....7
- 7 Saprophytic; stroma aplanate to aplanopulvinate, sessile and attached evenly or by a central point, or stipitate; stroma fairly extensive, variable but usually at least 10 mm diam.; ostioles medium papillate; spores navicular to crescentic, with acute or rounded ends, dark brown to black,  $7.5-9.0 \times 30.5-37.5\mu$   
*Kretzschmaria deusta* (Hoffm. ex Fr.) Martin  
*Ustulina deusta* Hoffm. ex Petrak
- 7' Saprophytic; stroma aplanate but less variable than above; ostioles prominent papillate; spores navicular, dark brown,  $12.0 \times 40.5\mu$
- 7'' Parasitic on numerous tropical crops, rubber, tea, etc.; stromata aplanate or resupinate with marked zonate growth, or multiclavulate and coalescent; ostioles not prominent; spores crescentic, with rounded ends, dark brown to black,  $8-13 \times 30-48\mu$   
*Kretzschmaria zonata* (Lév) Martin  
 syn. *Ustulina zonata* Lévillé
- 8 (2) Clavata or clavulae with distinct sterile excentric apices.....21
- 8' Clavata or clavulae terminating growth.....9
- 9 Stipes with irregularly uneven surface.....10
- 9' Stipes smooth.....11
- 10 Ostioles papillate but not prominent; subiculum present on lower part of stipe; spores absent in type material (NYBG)  
*Kretzschmaria tuckeri* Ined.? (Plate I:6)
- 10' Ostioles prominent papillate; subiculum absent; spores gibbous, broad ended, dark brown,  $5.0 \times 5.5 \times 9.0-10.5\mu$   
*Kretzschmaria microspora* Hennings
- 11 (9) Spores not exceeding  $14\mu$  in length; stromata less than 4 mm high.....12
- 11' Spores longer than  $14\mu$ , average spore lengths over  $20\mu$ ; stromata larger.....13
- 12 Spores  $4.5-6.5 \times 10.0-12.5\mu$ , gibbous, narrow-ended, dark brown, without visible sheaths  
*Kretzschmaria heliscus* (Mont.) Masse  
 syn. *Kretzschmaria sessilis* Patouillard
- 12' Spores  $5.0 \times 11.5\mu$ , gibbous to navicular, narrow-ended, pale brown, with prominent sheaths  
*Kretzschmaria chardoniana* (Mill.) Martin  
 syn. *Penzigia chardoniana* Miller
- 13 (11) Spores with spiral germ slits.....14
- 13' Spores with straight germ slits.....15

- 14 Outer layer yellow ochre; stromata unbranched or producing up to 3 clavulae; spores crescentic, narrow-ended, dark brown,  $11.0 \times 38.0 \mu$   
*Kretzschmaria pechuellii* Hennings
- 14' Outer layer dull brown; stromata producing up to 5 clavulae; spores crescentic, gibbous or navicular, with narrow ends, dark brown,  $14.5 \times 46.0 \mu$   
*Kretzschmaria spinifera* Ellis & Everhart
- 15 (13) Ostioles prominent papillate ..... 16  
 15' Ostioles not prominent ..... 17
- 16 Stromata up to 5 mm high with 2–10 clavulae per stroma; spores crescentic, broad-ended, medium to dark brown,  $8.5 \times 32.5 \mu$   
*Kretzschmaria micropus* Fries
- 16' Stromata larger, up to 20 mm high, with 1–16 clavulae per stroma; spores gibbous to navicular, narrow-ended, dark brown,  $10.0 \times 40.0 \mu$   
*Kretzschmaria verrucosa* (Mill) Martin  
 syn. *Penzigia verrucosa* Miller
- 17 Subiculum present on lower parts of the stipes; upper surface of clavulae convex; spores navicular, narrow-ended, dark brown,  $8.0-9.0 \times 33.5-34.0 \mu$   
*Kretzschmaria coenopus* (Fr.) Saccardo (Plate I:16)
- 17' Subiculum absent ..... 18
- 18 Stromata unbranched, or producing less than 16 clavulae ..... 19
- 18' Stromata indefinitely ramose, clavulae more than 16 and up to 200, close together; ostioles not prominent; spores navicular to crescentic, narrow-ended, medium brown,  $8.5-9.0 \times 27.0-36.0 \mu$   
*Kretzschmaria lichenoides* Ricker (Plate I:14)
- 19 Upper surface of clavulae convex, ostioles minutely papillate; stromata usually of small size, less than 5 mm high; spores navicular to crescentic, narrow-ended, medium brown,  $8.0 \times 30.0 \mu$   
*Kretzschmaria pusilla* Ellis & Everhart
- 19' Upper surface of clavulae usually flat, ostioles medium papillate; stromata above 5 mm high ..... 19
- 20 Spores gibbous to navicular, narrow-ended, medium to dark brown,  $8.5-9.5 \times 26.0-27.5 \mu$   
*Kretzschmaria clavus* Fries
- 20' Spores crescentic, narrow-ended, medium to deep brown,  $7.0-7.5 \times 28.0-32.0 \mu$   
*Kretzschmaria puiggarii* (Speg.) Saccardo  
 (This is possibly only a variety of *K. clavus*)
- 21 (10) Stromata unbranched or producing less than 16 clavulae ..... 29
- 21' Stromata branched indefinitely; 50–100 clavulae per stroma ..... 24
- 22 Ostioles prominent, beak or spout shaped ..... 23
- 22' Ostioles papillate but not prominent, ectostroma grey, continuous; spores gibbous, broad or narrow ended, medium brown,  $12.0 \times 26.5 \mu$   
*Kretzschmaria proxima* Patouillard
- 23 Clavulae sessile and close together; ectostroma dull brown at maturity, in polygonal crusts; spores gibbous to crescentic, narrow-ended, dark brown,  $8.5-10.5 \times 31.5-34.5 \mu$   
*Kretzschmaria aggregata* (Welw. & Currey) Saccardo (Plate I:5)  
 syn. *Hypoxylon cyclopicum* Spegazzini
- 23' Clavulae short stipitate, close dispersed; ectostroma fawn brown at maturity, in polygonal crusts; spores navicular, narrow-ended, dark brown,  $12.0 \times 41.0 \mu$   
*Kretzschmaria novoguineensis* Hennings (Plate I:3, 8)
- 24 (21) Branching of the stromata arborescent or ascending; ostioles prominent; spores gibbous to navicular, narrow-ended, dark brown,  $8.0 \times 28.5 \mu$   
*Kretzschmaria cetrarioides* (Welw. & Currey) Saccardo (Plate I:15)
- 24' Branching of the stromata radiate, from central point; ostioles papillate but not prominent; spores gibbous to navicular, narrow-ended, dark brown,  $8.5 \times 26.5 \mu$   
*Kretzschmaria xylarioides* Spegazzini (Plate I:17, 18)

1. *Kretzschmaria deusta* (Hoffm. ex Fr.) Martin nov. comb. (Plate I:10-13)

sub *Hypoxylon deustum* (Hoffm. ex Fr.) Greville

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- 6, 324, (1928). Miller J. H. *Bothalia* 4, 255, (1942); World species of *Hypoxylon* 84, (1961).  
 sub *Hypoxylon magnosporum* Lloyd C. G. Myc. Writ. 6, 1054, (1921).  
 sub *Hypoxylon ustulatum* Bulliard  
 Berkeley M. J. Journ. Linn. Soc. 10, 383, (1869); Grevillea 4, 94 (1876). Greville R. K. Scottish Crypt. Flora 6, 324, (1828). Kickx J. Flora Crypt. Louvain 115, (1835); Flore Crypt. Flandres 306, (1867). Montagne J. F. C. in Sagra: Hist. Cuba 339, (1838—1842); in Gray: Hist. Chile VII, 439, (1850). Quélet L. Champ. Jura & Vosges 490, (1875). Welwitsch F. & F. Currey Jour. Linn. Soc. 26, 282, (1868).  
 sub *Nummularia macrospora* Patouillard N. Bull. Soc. Myc. de Fr. 3, 175, (1887).  
 sub *Sphaeria deusta* Hoffm.  
 Albertini J. D. & L. v. d. Schweinitz Conspectus fungi Lusitiae 6, (1805). Berkeley M. J. in Smith: English Flora 5, (2), 240, (1836). Fries E. M. Syst. mycol. 345, (1823). Greville R. K. Flora edinensis 355, (1824). Hoffman G. F. Veg. Crypt. 1, 3, (1787). Persoon C. H. Obs. mycol. 19, (1796); Syn meth. fung. 16, (1801—1808).  
 sub *Sphaeria maxima* Weber Spic. Flor. Goett. 286, (1778).  
 sub *Sphaeria undulata* Hooker W. J. Flora Scotica II, 5, (1821).  
 sub *Sphaeria versipellis* Tode Fung. Meckl. 2, 55, (1791).  
 sub *Ustulina deusta* Hoffm. ex Petrak  
 Brefeld O. Untersuchungen aus dem Gesamtgebiete der Myk. X. Ascomyceten 2, 260, (1891). Bresadola G. & P. A. Saccardo Malpighia 11, 293, (1897). Cooke M. C. Handbook of British Fungi II, 792, (1871). Dennis R. W. G. British Cup Fungi 179, (1960). Mycologia 20, 327, (1928); Trans. Brit. Mycol. Soc. 15, 143, (1930). Petrak F. Ann. Mycol. 19, 279, (1921).  
 sub *Ustulina maxima* (Weber) Wettstein  
 Ferdinandsen C. & O. Winge Mykologiske Ekskursionsflora 400, (1893). Hennings P. Hedwigia 40, 339, (1901); Ibid 47, 259, (1908). Lindau G. in Engler & Prantl: Die natürlichen Pflanzenfamilien I, 483, (1897); Die mikroskopischen Pilze in Krypt. f. Anfänger 2, (1), 134, (1922). Schroter J. in Cohn: Kryptflor. Schlesien 465, (1908). Traverso J. B. Flor. Ital. Crypt. 1, 36, (1906).  
 sub *Ustulina vulgaris* Tulasne L. & C.  
 Berkeley M. J. & C. E. Broome Journ. Linn. Soc. 14, 119, (1875). Bizzozero G. Flora veneta critt. 1, 199, (1885). Blaisdell D. J. Phytopath. 29, 2, (1939). Bresadola G. Hedwigia 35, 298, (1896). Bresadola G. & C. Roumeguère Revue Mycol. 12, 38, (1890). Brooks F. T. Plant Diseases 235, (1953). Campbell W. A. & R. W. Davidson Journ. Forestry 38, 474—477, (1940). Carter J. C. Phytopath. 28, 4—5, (1938). Cooke M. C. Handbook of Australian Fungi 290, (1892). Davidson R. W. et al. U.S. Dept. Agr. Tech. Bull. 785, 1—65, (1942). Ellis J. B. & B. M. Everhart Journ. Mycol. 4, 111, (1887); N. Amer. Pyren. 662, (1892). Fuckel L. Symbolae Mycologicae 235, (1869—1870). Hennings P. Hedwigia 36, 227, (1897). Jacewski A. L. Bull. Soc. Myc. de France 11, 112, (1895). Lambotte E. Flora mycol. belge 425, (1880). Ibid 6, 1093, (1921). Nitschke T. Pyr. Germ. 1, 21, (1867). Rabenhorst L. Kryptflor. Deutsch II, 869, (1887). Saccardo P. A. Fungi Ital. 1143 (1877—1886). Theissen F. Ann. Mycol. 6, 533, (1908); Ibid 7, 10, (1909). Tulasne L. & C. Selecta Fungorum Carpol. 2, 22—24, (1863). Wilkins W. H. Trans. Brit. Mycol. Soc. 18, 320—346, (1934); Ibid 20, 133—156, (1936); Ibid 22, 47—93 (1938); Ibid 23, 65—85, (1939).

The stromata are divided into a flat or convex fertile portion and a sterile base of varying extent. Periodic collections made from old logs of *Olea capensis* in the Garden of Eden, Knysna, show that the morphology of the fungus varies according to the nature of the host substrate. On hard wood and bark not greatly decayed, the fertile stroma is aplanate, irregularly effused and crustose,  $11\text{--}20 \times 12\text{--}36 \times 1.8\text{--}3.0$  mm and the sterile base is very short or practically undeveloped. The stroma is close in general structure to that of *Hypoxylon entoleucum*, except for the deeper immersion and greater degree of coalescence of the perithecia and general attachment only at the mid-point of the stroma to the wood. On decorticated soft wood, the attachment may be greatly extended into a distinct stipe  $2.5\text{--}4.0 \times 10\text{--}15$  mm, extending into the substrate. On

bark, where the wood is greatly decayed beneath, the fertile stroma itself varies in form from the flat aplanate type to small pulvinate or conic, and this similarity to typical species of *Kretzschmaria* is strengthened by indefinite ramification of the stroma beneath the bark and production of several fertile heads by the same branching system. The latter tends to be a perennial occurrence.

The ectostroma is at first white, bearing greenish grey conidia over the surface except for a sterile marginal zone up to 5 mm wide; later it becomes pale grey brown and finally dark grey to black, continuous, with age becoming cracked concentrically or scabrous, either sloughing off or merging with the carbonous entostroma. Entostroma white, fleshy, of variable extent, becoming carbonous above the perithecia and corky beneath; the latter tissue disintegrating after maturity. Perithecia large, globose,  $1200-1400 \times 1000-1200\mu$ ; ostioles distinct papillate. Asci cylindric or clavate, usually long stalked,  $170-330 \times 11-14\mu$ ; stipes  $60-170\mu$ . Spores elliptic, navicular to crescentic, with pointed or rounded ends and prominent gelatinous sheaths, dark brown to almost black,  $6.0-12.0 \times 2.3-3.0-36.5\mu$ , ave.  $8.4 \times 30.9\mu$ .

South African hosts: *Olea capensis*, *Ocotea bullata*

*Material examined:*

A large quantity of material in the herbaria cited. Martin 50—52, 377, 463, 1050; Garden of Eden, Knysna, Western Cape, South Africa (1958, 1959) Martin 552; Hogsback, Alice, E. Cape, South Africa, (1959). Martin 1958; Stoneybrook, Rockland Co., NY State, U.S.A., (1963). Martin 1697; Mt. Toby State Forest, Mass, U.S.A., (1963). Martin 1815 ex Carroll 124; Faksingskor, Denmark, (1962).

**Cultural characters (Plate IV:1, Plate V:3):**

Colonies velvet-fleecy, pure white, opaque with fine texture, uniform. Margin distinct, 7—15 mm wide, sometimes with characteristic plumose fronds, otherwise canescent, segmented or lobed, compact. Carbonization of the medium takes place between 10 & 20 days and is extensive. Growth rate moderate, 2.6 mm/day at 25°C. Growth on other media similar; Czapek cultures extremely furrowed and distorted. No coremia have been observed in culture.

**Microscopic characters (Fig. II:2, 5):**

Primary mycelium undiagnostic, maximum diameter of marginal hyphae  $=2.3\mu$ . Secondary mycelium peculiar, consisting of wide plate-like masses of large cells  $3.0-16 \times 10-18\mu$  which are carbonized and dark in colour. They arise by indefinite branching and anastomosis of very short hyphae.

**Imperfect stage: (Fig. II:3—4; Plate I:10).**

Brooks F. T. (1953), Lindau G. (1897), loc. cit. Wilkins W. H. Trans. Brit. Mycol. Soc. 23, 65—85, (1939).

Conidiophores and conidia have never been observed in culture, whether on agar or wood. On young stromata they are formed in a palisade 82—100 $\mu$  high,



closely compacted. Each consists of a lateral indefinitely branched system,  $2.2-2.5\mu$  in diameter, producing erect fertile hyphae, which in turn sometimes bear short side branches also giving rise to conidia. The fertile branches are smooth or partly serrate,  $10-19 \times 1.9-2.5\mu$ . Conidia are pleuracrogenous, elliptic to oval, very pale grey collectively,  $2.0-2.9 \times 4.6-7.7\mu$ , ave.  $2.4 \times 6.0\mu$ .

*Kretzschmaria deusta* is a species defying generic boundaries, but may be regarded as an intermediate between *Hypoxylon* and the *xylariaceous* genera. It is important to note that no difference in cultural characters was evident among cultures taken from stromata of widely different form.

## 2. *Kretzschmaria heliscus* (Mont.) Massee (Plate I:2)

Dennis R. W. G. Kew Bull. **1957**, 313, (1957). Lloyd C. G. Myc. Writ. **5**: Large Pyrenomycetes II, 22, (1919). Massee G. Kew Bull. **1898**, 118, (1898). Miller J. H. Monog. Univ. Puerto Rico B **2**, 208, (1934).  
sub *Hypoxylon heliscus* Montagne J. F. C. Ann. Sci. Nat. II, **13**, 355, (1840).

Stromata pulvinate,  $0.9-1.9 \times 1.5-2.4 \times 0.5-1.8\mu$ , with one or several (<20) clavata per stroma, on distinct stipes  $0.5-1.0 \times 0.7-2.0\mu$ . Subiculum present, rough, densely matted, dull brown to purple brown; hyphae sparingly branched, rosy, uniform,  $1.8-4.5\mu$  in diameter. Ectostroma persistent, crustose, continuous or splitting in polygonal crusts, dull brown to black. Entostroma outwardly carbonaceous, black; basal tissue fleshy or corky, solid, dull white to cream. Perithecia 2-8 per clava, immersed, globose,  $500-600 \times 500-700\mu$ ; ostioles medium or prominent papillate. Asci cylindric,  $115-135 \times 4-5\mu$ ; spores gibbous to navicular narrow ended, dark brown,  $3.5-7.0 \times 8.5-14.0\mu$ , ave.  $5.3 \times 11.2\mu$ .

### Material examined:

Copeland; on *Ficus*, Las Banas, Philippines (1932), (NYBG). Martin 1510; San Blás, Nayarit, Mexico, (1962).

Cultural characters: (Plate V:1, 2. See also Martin (1967) Plate V:5):

Colonies velvet-felty, serial mycelium somewhat plumose but otherwise uniform, pure white. Margin distinct, entire, plumose, hyphae compact. Carbonization extensive. Growth moderate, 2.3 mm/day at 25°C.

### Microscopic characters:

Primary mycelium undiagnostic, maximum diameter or marginal hyphae =  $1.2\mu$ . Secondary mycelium loose,  $1.2-2.5\mu$  in diameter.

Conidiophores and conidia (Plate VII:6). See also Martin (1967) Plate V:5.

The conidiophores are borne on small rosy coremia,  $0.3-5.5 \times 3.2-18$  mm, that are unbranched or with up to 5 branches. Each whole coremium or

sector is curved, aristate or fan shaped, without dark mycelium, white, with sporadic fertile areas. The conidiophores are developed irregularly,  $135-160 \times 1.5-4.5\mu$ , and are branched dichotomously or ternately to the second degree or indefinitely. The fertile branches are borne in trident formation, swollen clavate but smooth in outline, with unspecialized to distinct globose heads,  $4.3-11.2 \times 1.5-3.7\mu$ . Conidia acrogenous, sessile, clavate with narrow rounded distal ends and narrow truncate bases, pale grey,  $1.2-1.6 \times 6.7-9.6\mu$ , ave.  $1.3 \times 7.9\mu$ .

**Xylaria** Hill, J. D. A General Natural History of the Animals, Vegetables and Minerals, 62, (1751).

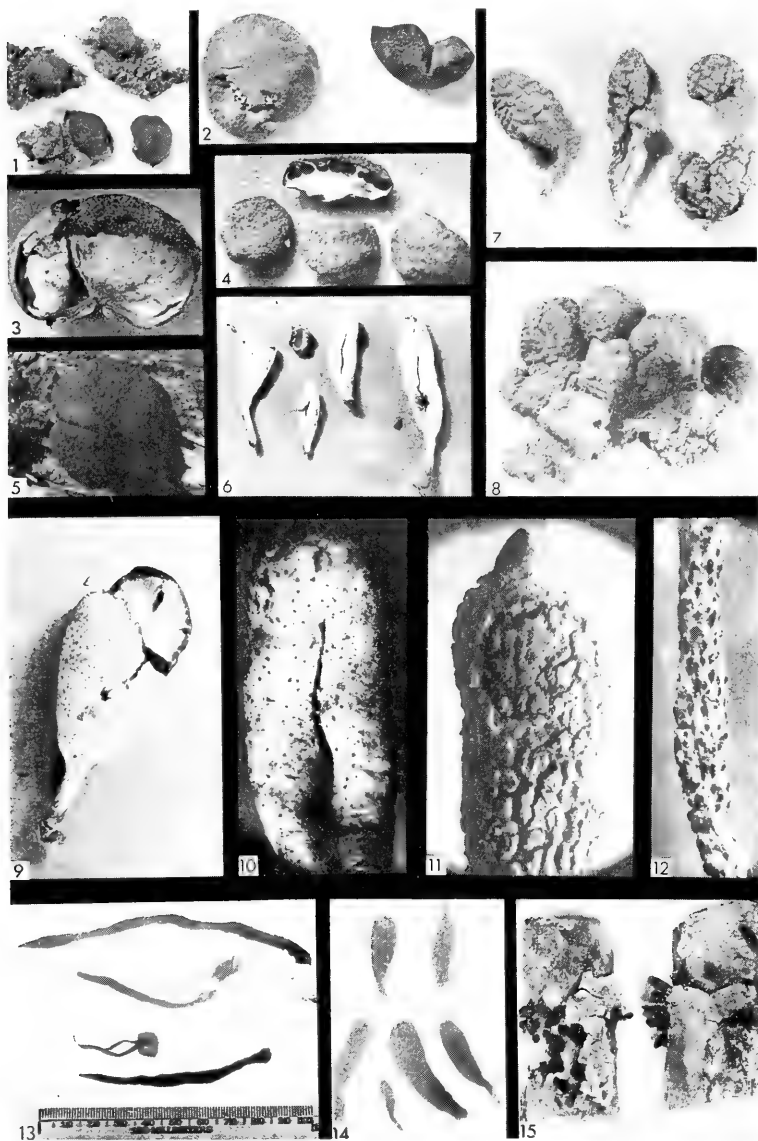
This is the oldest genus of the Xylariaceae and still the best known. Customarily recognized by the cylindrical shape of the stroma and the black surface covering a white interior, the fungi included here also represent a somewhat radical departure from all the other genera except *Thamnomyces* in that the perithecia are oriented horizontally instead of vertically in relation to the growing apex, and the fertile portion is raised above the substrate level through development of a stipe.

Dennis (1957) has followed Dumortier (1822) in adoption of the term *Xylosphaera* for the genus. The writer regards this as serving little purpose: the name *Xylosphaera* is little known in contrast to *Xylaria*, and Dumortier's definition adds nothing to, nor detracts from, the original definition of the genus. Recently (see Report, 1968) *Xylaria* was conserved against *Xylosphaera*.

The genus *Xylobotryum* Patouillard (1895) is excluded from *Xylaria* on account of the reported biseptate nature of the spores of the type, *X. andinum* Pat. No type material in the genus has been examined except that of *X. rickii* Lloyd. This species is misplaced since it is a good *Xylaria*.

PLATE II. Stromata (Cont.)

1. *Xylaria avellana*  $\times (1.6)$
2. *Xylaria fibula*  $\times (1.6)$
3. *Xylaria cranioides*  $\times (1.6)$
4. *Xylaria macrospora*  $\times (1.6)$
5. *Xylaria berteri*  $\times (1.8)$
6. *Xylaria enterogena*  $\times (1)$
- 7, 8. *Xylaria anisopleura*: Variation from sessile to stipitate stroma  $\times (1)$
- 9—12. Surface views of stromata
9. *Xylaria dealbata* (Xyloglossa)  $\times (1)$
10. *Xylaria enterogena* (Xyloglossa)  $\times (6)$
11. *Xylaria comosa* (Xylorugosa)  $\times (6)$
12. *Xylaria hypoxylon* (Xylorugosa)  $\times (6)$
13. *Xylaria leprosa*  $\times (0.4)$
14. *Xylaria castorea*  $\times (0.4)$
15. *Xylaria fioriana*  $\times (0.4)$



The same is concluded for the monotypic *Trachyxylaria* Möller (1901), because the spores are also reported as bisepitate. Further type material as well as that freshly collected has to be examined before determining the true relationship of these little-known fungi.

*Xylaria* has been traditionally divided into 4 sections dating from Fries (1851):

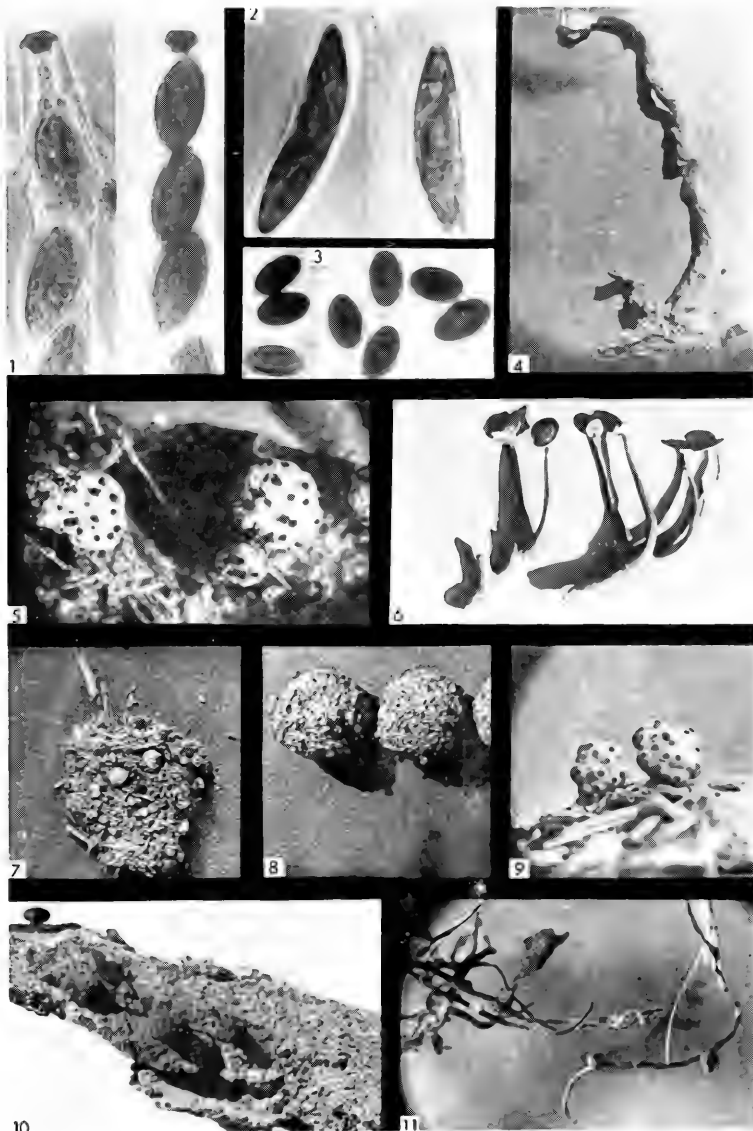
A. clava undique fertili	
a. stipite glabro	Xyloglossa
b. stipite vestito	Xylocoryne
B. Clava apice sterili	
a. stipite glabro	Xylostyla
b. stipite villosa	Xylodactyla

The evaluation of these as natural taxonomic units is difficult though the system is reasonably practicable as a broad artificial basis for the separation of species. The selection of only two characters, the presence or absence of a sterile apex and subiculum leads, however, to too much overlapping. Furthermore, it is difficult to know which one should take priority, since both are variable. The writer takes the view that there are no sharp lines between these four classes, and that there are several common species, including *X. polymorpha*, *X. curta*, *X. arbuscula*, and *X. anisopleura* that show a sufficiently wide degree of interspecific variation as to render the basis of this classification untenable.

The genus *Xylaria* is best defined, and its division into natural units facilitated, by two refinements. Firstly, those species without an ectostroma should be placed in *Podosordaria*, for reasons given later. Secondly, if the nature of the ectostroma, whether smooth and continuous or rough and divided into plaques, is given precedence over other characters, the two resultant groups within *Xylaria* show much less overlap in character and there are very few intermediate species.

#### PLATE III. Stromata (Concl.)

- 1—3. Asci and spores
  1. *Xylaria anisopleura*: Young and mature asci with prominent apical plugs  $\times$  (210)
  2. *Xylaria tabacina*: Spores with spiral germ slits  $\times$  (540)
  3. *Poronia punctata*: Spores with linear germ slits and gelatinous sheaths  $\times$  (540)
4. *Podosordaria macrorrhiza*  $\times$  (3)
5. *Poronia punctata*: White ectostroma and black ostioles  $\times$  (6)
6. *Poronia oedipus*: Multiclavate stromata  $\times$  (3)
7. *Poronia punctata*  $\times$  (1·5)
- 8, 9. *Podosordaria leporina*
  8.  $\times$  (1·5)
  9.  $\times$  (6)
10. *Podosordaria plumosa*  $\times$  (2)
11. *Podosordaria hippotrichioides*  $\times$  (7)



Section 1. *Xyloglossa* Fries (Plate II:9, 10):

Stromata usually large, clavate, often with bulbous apices and decussate or ill-differentiated stipes. Surface of stroma smooth; ectostroma continuous or nearly so, usually variously coloured or some shade of brown or purple-grey becoming black with age. Perithecia variously oriented, immersed or very rarely evident in outline, developed over the entire clava. Subiculum infrequent, and not well developed when present.

Section 2. *Xylorugosa* Martin (Plate II:11, 12):

Stromata extremely variable in size and shape, pulvinate, linear, or clavate; apices not usually bulbous. Surface of stroma verrucose, rarely smooth; ectostroma continuous or broken up into linear or polygonal corky plaques that may remain visible at maturity or become partially absorbed into the entostromal crust or flake off. Usually the ectostroma is some shade of light or dark brown at maturity, though white initially. Perithecia usually lateral, occasionally variously oriented, often vaguely evident or easily discernible in outline, developed over the entire clava or absent at the top so that the apex is umbonate or linear. Subiculum characteristic, sometimes tomentose covering the stipe and base of the stroma.

The division below this level, especially in the second and larger group, however, does become arbitrary due to the inconsistent correlation of characters. Those species, for example, corresponding to Fries' section *Xylodactyla* which show a preference for seed coats and various substrates which are not lignicolous, are also linear in form. However, there are several others of similar form that occur on wood along with the bulbous and clavate types. Likewise, several species, e.g. *X. anisopleura*, previously referred to, exhibit pulvinate, cylindric and clavate stromata, sometimes without a stipe. The writer has thought fit to include several species of *Penzigia* together with polymorphic species of *Xylaria* that vary from pulvinate to cylindric (e.g. *X. anisopleura*), or which have separate perithecia as a separate subgroup within *Xylorugosa*. This stromal polymorphism is paralleled by variation in form of development of conidiophores from parallel to irregular on various types of coremium (see Plates II & VII). In the other species of *Xylorugosa* the stroma is consistently cylindric and the conidiophores always in parallel arrangement on an anistate coremium.

Following is a key to some of the species, drawn from the literature and authentic material:

- |    |   |    |
|----|---|----|
| 1' | Ectostroma forming a smooth crust at maturity, without furrows, continuous or minutely areolate or cracked; sometimes brightly coloured. Apex rarely infertile (sect. <i>Xyloglossa</i> ).....  | 2  |
| 1' | Ectostroma rugose or tomentose, continuous or forming linear or polygonal plaques at maturity; surface characteristically furrowed between the perithecia, usually dull brown to black. Apex fertile or produced as a sterile point.<br>(sect. <i>Xylorugosa</i> )..... | 19 |
| 2  | Subiculum absent, stromal apex sterile or fertile.....  | 3  |
| 2' | Subiculum present, apex fertile.....  | 12 |
| 3  | Apex sterile; ectostroma fawn brown to dull brown or grey; spores crescentic, narrow ended, medium brown, with spiral germ slits, 7·0—8·0 × 42·0—42·5 μ<br><i>Xylaria platypoda</i> (Lév.) Fries  |    |
| 3' | Apex fertile.....   | 4  |
| 4  | Spores with spiral germ slits.....  | 5  |
| 4' | Germ slits straight.....  | 6  |
| 5  | Ectostroma dull white, basal tissue dull white to grey; stroma clavata to obovate;  |    |

- spores navicular to crescentic with acute or mucronate ends, medium to dark brown,  $8\cdot0\times29\cdot0\mu$
- 5' *Xylaria ridleyi* Massee  
Ectostroma cream or yellow, entostroma cream at centre; stroma usually clavate, narrowing down to the base; spores navicular to crescentic, narrow ended, medium to dark brown,  $6\cdot5-7\cdot5\times17\cdot0-20\cdot0\mu$
- 5' ' *Xylaria enterogena* Montagne  
Ectostroma burgundy brown, entostroma dull yellow to black at centre; stipe distinct; spores crescentic, narrow ended, dark brown,  $7\cdot0-7\cdot5\times17\cdot5-24\cdot0\mu$
- 6 (4) *Xylaria telfairii* Berkeley  
Ectostroma white at maturity ..... 7
- 6' Ectostroma some shade of brown ..... 9
- 7 Stroma large; clava hemispheric or pileate, with a long robust stipe; spores equilateral, broad ended, dark brown, with prominent sheaths,  $6\cdot0\times13\cdot5\mu$
- 7' *Xylaria agariciformis* Cooke & Massee  
Stroma clavate or cylindric ..... 8
- 8 Stroma clavate to obovate; spores gibbous to navicular, with acute ends or mucronate, dark brown to black,  $7\cdot0-7\cdot5\times28\cdot0-31\cdot0\mu$
- 8' *Xylaria dealbata* Berkeley & Broome (Plate II:9)  
Stroma cylindric; spores equilateral, broad-ended, amber to pale brown,  $3\cdot0\times6\cdot5\mu$
- 9 (6) *Xylaria muscula* Lloyd  
Spores clearly appendiculate, or in old material appearing with one end acute and the other broad or truncate, navicular to crescentic, medium brown,  $7\cdot0\times21\cdot5\mu$ . Stromata brown to purple brown, involute
- 9' *Xylaria involuta* Klotzsch  
Spores not appendiculate, with both ends similar ..... 10
- 10 Spores not exceeding  $15\mu$  long ..... 11
- 10' Spores  $6\cdot5\times19\cdot0\mu$ ; crescentic, narrow ended, dark brown; stroma large usually 30 mm long, cylindric with sunken perithecia
- 11 *Xylaria olobapha* Berkeley  
Stromata cylindric, spores with acute ends, gibbous, medium brown,  $4\cdot5\times8\cdot5-10\cdot0\mu$
- 11' *Xylaria plebeja* Cesati  
Stromata clavate, spores with broad or narrow ends, gibbous to navicular, amber to medium brown,  $4\cdot0-5\cdot5\times11\cdot0-14\cdot0\mu$
- 12 (2) *Xylaria allantoides* Berkeley  
Spores with spiral germ slits ..... 13
- 12' Germ slits straight ..... 14
- 13 Ectostroma cream or yellow; stromata usually clavate, narrowing down to the base; spores navicular to crescentic, narrow ended, medium to dark brown,  $6\cdot5-7\cdot5\times17\cdot0-20\cdot0\mu$
- 13' *Xylaria enterogena* Montagne (Plate II:6, 10)  
Ectostroma burgundy to dull brown; stromata clavate but with a distinct stipe; spores navicular to crescentic, narrow-ended, dark brown, with prominent sheaths,  $7\cdot0\times20\cdot0\mu$
- 14 (12) *Xylaria tabacina* (Kickx.) Berkeley (Plate III:2)  
Ostioles papillate, in the centre of a conspicuous circular raised or depressed area, dark or covered with white granular material, sometimes also with a white or brown rim; ectostroma purplish brown then dull fuscous to black, spores crescentic, broad ended, dark brown,  $4\cdot5-6\cdot0\times10\cdot0-16\cdot5\mu$
- 14' *Xylaria guianensis* Montagne  
Ostioles not annulate ..... 15
- 15 Stromata globose to oval, with outer layer smooth or minutely and reticulately cracked, fuscous grey with ostioles darker but often indistinct; spores crescentic, with broad or narrow ends, dark brown,  $5\cdot5-8\cdot5\times24\cdot5-25\cdot0\mu$
- 15' *Xylaria obovata* Berkeley  
Stromata clavate or cylindric ..... 16
- 16 Stromata of moderate size, not more than 7 cm long and 1.5 cm diam. .... 17
- 16' Stromata large, at least 7 cm long and 1 cm diam. .... 18

- 17 Spores equilateral to gibbous, narrow ended, dark brown to black,  $3.5-4.5 \times 7.5-8.0\mu$ ; ectostroma dull murky brown; stromata gregarious, not  $> 37$  mm high  
*Xylaria cubensis* Montagne
- 17' Spores gibbous to crescentic, with narrow distal ends, dark brown,  $4.0-5.0 \times 8.0-12.0\mu$ ; ectostroma burgundy brown; stromata solitary up to 65 mm high, somewhat twisted  
*Xylaria myosurus* Montagne
- 18 (16) Stipes very short; clavate massive up to 20 cm long; ectostroma dark purple grey; spores gibbous to crescentic, narrow ended, dark brown to black,  $5.0-6.5 \times 12.5-15.5\mu$   
*Xylaria poitei* (Lév.) Fries
- 18' Stipes well developed, up to 4 cm long; clavata up to 7 cm long; ectostroma purplish grey with white streaks; spores gibbous to navicular, narrow ended, dark brown,  $6.5 \times 19.5\mu$   
*Xylaria conocephala* Berkeley & Curtis
- 19 (1) Subiculum absent, apex fertile.....20  
 19' Subiculum absent, apex sterile.....33  
 19'' Subiculum present, apex fertile.....36  
 19''' Subiculum present, apex sterile.....56  
 20 Stipe not developed, stroma attached at centre only.....21  
 20' Stipe evident though sometimes decussate from clava.....28  
 21 Spores less than  $20\mu$  long.....22  
 21' Spores greater than  $20\mu$  long.....25  
 22 Entostromal crust containing orange particles visible on inspection; spores equilateral, broad ended, medium brown,  $5.5 \times 10.5\mu$   
*Xylaria cinnabarina* Cooke & Massee
- 22' Entostroma crust entirely black.....23  
 23 Spores navicular, narrow-ended, medium brown, with linear or spiral germ slits,  $6.0 \times 13.5\mu$ ; stromata small pulvinate  
*Xylaria ayresii* (Berk. & Cke.) Martin  
 syn. *Penzigia ayresii* (Berk. & Cke.) Miller
- 23' Spores equilateral or gibbous with straight germ slits.....24  
 24 Stromata aplanopulvinate to oval or circular, 9-35 mm diam., with convex or flattened surface and concave undersurface, attached at one narrow point only; spores gibbous or equilateral, narrow ended, black,  $6.5-8.0 \times 11.0-13.5\mu$   
*Xylaria enteroleuca* (Speg.) Martin  
 syn. *Penzigia enteroleuca* (Speg.) Miller  
*Hypoxylon enteroleucum* Spegazzini
- 24' Stroma pulvinate, 4-19 mm diam. with convex surface and flat undersurface, with broad central attachment, spores  $5.0 \times 11.5\mu$   
*Xylaria berteri* (Mont.) Cooke  
 syn. *Penzigia berteri* (Mont.) Miller  
*Hypoxylon berteri* Montagne
- 25 (21) Spores with spiral germ slits; stroma usually variable in form; ectostromal plaques polygonal, dull brown, entostroma dull yellow, ostioles prominent papillate; spores navicular to crescentic, with narrow or acute ends, dark brown  $6.5-11.0 \times 18.0-29.5\mu$   
*Xylaria anisopleura* (Mont.) Fr.  
 syn. *Xylaria scruposa* Fr.  
*Xylaria tuberiformis* Berk.  
*Kretzschmaria rugosa* Earle
- 25' Germ slits straight.....26  
 26 Stromata large, globose or pulvinate, 14-27 mm diam., 10-15 mm high; ectostrome ochre brown, entostroma dull yellow at centre; spores navicular to crescentic, acute ended, dark brown,  $9.0 \times 30.0\mu$   
*Xylaria cranioides* (Sacc. & Paol.) Martin (Plate II:3)  
 syn. *Penzigia cranioides* Sacc. & Paol.
- 26' Stromata smaller, not exceeding 11 mm diam. and 6 mm high.....27  
 27 Perithecia  $600-700 \times 700-800\mu$ ; spores navicular to crescentic, narrow ended, dark brown,  $8.5 \times 24.5\mu$   
*Xylaria fibula* Massee (Plate II:2)



- 27' Perithecia 700—800 × 1200—1300 $\mu$ ; spores navicular to crescentic, broad-ended, dark brown, 10·0 × 33·0 $\mu$   
*Xylaria avellana* (Ces.) Martin (Plate II:1)  
 syn. *Penzigia avellana* (Ces.) Miller
- 27' Perithecia 1200—1800 × 1500—1800 $\mu$ ; spores equilateral, narrow ended, medium to dark brown, 17·5 × 39·0 $\mu$   
*Xylaria macrospora* (Penz. & Sacc.) Martin (Plate II:4)  
 syn. *Penzigia macrospora* Penzig & Saccardo
- 28 (20) Spores 6·5—11·0 × 18·0—29·5 $\mu$ , navicular to crescentic, with narrow or acute ends, dark brown; germ slits spiral  
*Xylaria anisopleura* (Mont.) Fries  
 syn. *Xylaria scruposa* Fries  
*Xylaria tuberiformis* Berkeley  
*Kretzschmaria rugosa* Earle
- 28' Spores less than 20 $\mu$  long; germ slits straight.....29
- 29 Stromata clavate, or oblong to ovate or cylindric.....30
- 29' Stromata strictly linear cylindric.....32
- 30 Spores crescentic, stromata robust, usually of fairly large size.....31
- 30' Spores gibbous, with narrow ends, dark brown, 6·0 × 10·5 $\mu$ ; stromata of moderate size, up to 4 mm long. On seeds, often buried in soil.  
*Xylaria oxyacanthae* Tulasne
- 31 Ectostroma plaques yellow ochre, turning dull brown, square or circular; stromata oblong to ovate; spores crescentic, narrow ended, medium brown to black, 4·0—5·0 × 9·0—10·5 $\mu$   
*Xylaria curta* Fries
- 31' Ectostroma plaques dull brown to black, verrucose; stromata ovate to cylindric; spores crescentic with narrow ends, medium brown, 7·0 × 12·0 $\mu$ .....29  
*Xylaria clavata* Scopoli
- 32 (29) Basal tissue beneath crust coloured yellow; ectostroma black, surface wrinkled; spores equilateral to navicular with narrow or acute ends, 4·5—5·0 × 9·0—11·0 $\mu$   
*Xylaria luteostroma* Lloyd
- 32' Basal tissue dull white; ectostroma dull brown, surface almost smooth; spores navicular, narrow ended, pale to medium brown, 4·5 × 12·0 $\mu$   
*Xylaria papyriferi* (Link.) Fries
- 33 (19) Spores with spiral germ slits, gibbous, acute-ended, medium brown, 5·0 × 16·5 $\mu$ ; ectostroma yellow ochre; basal tissue dull white; perithecia evident  
*Xylaria juruensis* Hennings
- 33' Germ slits straight.....35
- 34 Ectostroma light-coloured, perithecia evident.....35
- 34' Ectostroma darker coloured, perithecia vaguely evident to immersed.....36
- 35 Ectostroma yellow ochre, basal tissue pure white, perithecia evident; spores gibbous to navicular, with narrow or acute ends, dark brown, 9·0 × 30·0 $\mu$   
*Xylaria luxurians* (Rehm) Lloyd
- 35' Ectostroma white; basal tissue cream; perithecia evident; spores navicular, narrow ended, dark brown, 4·0 × 8·5 $\mu$   
*Xylaria coccophora* Montagne
- 36 (34) Stromata small, not more than 4 mm high; perithecia globose in outline; basal tissue white to dull yellow; spores navicular to crescentic, broad-ended, medium brown, 4·5 × 11·0 $\mu$   
*Xylaria citrina* Massee
- 36' Stromata larger, perithecia evident or immersed, basal tissue differently coloured 37
- 37 Ostioles in truncate depressions; clavata cylindric, black with ectostroma poorly preserved; spores navicular to crescentic, broad ended, medium brown, 5·0 × 10·5 $\mu$   
*Xylaria gracilentia* Sydow
- 37' Ostioles not in truncate depressions.....38
- 38 Stromata narrow, basal tissue white, perithecia sunken or vaguely evident, not close crowded; spores with prominent gelatinous sheaths, navicular, narrow-ended, dark brown, 5·5 × 13·0 $\mu$   
*Xylaria arbuscula* Saccardo

- 38' Stromata robust, clavate, basal tissue cream; perithecia moriform, close crowded; spores without sheaths, gibbous, with broad or narrow ends, medium brown,  $5.0 \times 11.0 \mu$   
*Xylaria varians* Saccardo
- 39 (19) Spores with spiral germ slits.....40  
 39' Germ slits straight.....42
- 40 Ectostroma yellow ochre, forming polygonal plaques; stroma short clavate; spores crescentic, mucronate, medium to dark brown,  $7.5-8.0 \times 28.0-29.5 \mu$   
*Xylaria comosa* Montagne (Plate II:11)
- 40' Ectostroma differently coloured at maturity.....41
- 41 Ectostroma dull brown, continuous or composed of linear or polygonal plaques, sometimes intermediate on the same specimen; clava pulvinate to clavate or cylindric, stipe absent or well developed; spores navicular to crescentic, with narrow or acute ends, dark brown,  $6.5-11.0 \times 18.0-29.5 \mu$   
*Xylaria anisopleura* (Mont.) Fries  
 syn. *Xylaria scruposa* Fries  
*Xylaria tuberiformia* Berkely  
*Kretzschmaria rugosa* Earle
- 41' Ectostroma fawn brown to black, forming scabrid linear or polygonal plaques, sometimes intermediate in the same species; clava clavate or cylindric; stipe always present; spores navicular to crescentic, narrow ended, dark brown,  $5.5-6.0 \times 12.0-13.0 \mu$   
*Xylaria longipes* Nitschke
- 42 (39) Spores appendiculate, gibbous to crescentic, with narrow distal ends, dark brown to black,  $5.0-5.5 \times 10.0-13.0 \mu$ ; stromata very narrow, less than 2 mm diameter  
*Xylaria gracillima* Fries
- 42' Spores not appendiculate.....43
- 43 Basal tissue dull yellow; stromata narrow cylindric; spores oval, equilateral to navicular with narrow or acute ends,  $4.5-5.0 \times 9.0-11.0 \mu$   
*Xylaria luteostroma* Lloyd
- 43' Basal tissue white or cream.....44
- 44 Stromata of moderate size, narrow cylindric,  $1.5-3$  mm diam., on seeds including palm nuts.....45
- 44' Stromata more robust, at least 2 mm diam; substrate dead wood.....46
- 45 On palm nuts; spores gibbous to navicular, narrow ended, dark brown,  $5.5 \times 10.5 \mu$   
*Xylaria palmicola* Rehm
- 45' On deciduous fruits; spores gibbous, narrow ended, dark brown,  $6.0 \times 10.5 \mu$   
*Xylaria oxyacanthae* Tulasne
- 45' ' On deciduous fruits; spores gibbous to navicular, narrow ended, dark brown,  $7.0 \times 15.0 \mu$   
*Xylaria bruneriana* Seaver
- 46 (44) Stroma smooth, not furrowed or corrugated; perithecia entirely immersed; stroma cylindric; spores crescentic, narrow ended, dark brown,  $7.0 \times 17.5 \mu$   
*Xylaria euglossa* Fries
- 46' Stromal surface wrinkled or furrowed; perithecia immersed or evident in outline 47
- 47 Ectostroma light coloured.....48
- 47' Ectostroma chestnut brown to black.....50
- 48 Ectostroma white, stroma clavate; spores navicular, narrow ended, black,  $7.0 \times 23.0 \mu$   
*Xylaria fockei* (Miguel) Saccardo
- 48' Ectostroma fawn to pale brown; stroma clavate; spores narrow-ended, dark brown, of two types: oval, gibbous,  $4.0 \times 8.5 \mu$ ; and elliptic, navicular to crescentic,  $5.5 \times 13.5 \mu$   
*Xylaria rhopalopsis* Ellis & Everhart ined?
- 48' ' Ectostroma yellow ochre.....49
- 49 Clavata of moderate size,  $12-35$  mm long; interior pure white; spores crescentic, narrow ended, medium brown to black,  $4.0-5.0 \times 9.0-10.5 \mu$   
*Xylaria curta* Fries
- 49' Clavata usually large,  $70-80$  mm long; interior dull yellow to grey; spores crescentic, narrow-ended, dark brown,  $5.0 \times 12.0 \mu$   
*Xylaria grammica* Montagne

- 50 (47) Spores greater than  $15\mu$  long.....51  
 50' Spores less than  $15\mu$  long.....52  
 51 Ectostroma dull brown, basal tissues pure white, stromata usually variable in form; spores navicular to crescentic with narrow or acute ends, medium to dark brown,  $7\cdot0-9\cdot0\times21\cdot5-27\cdot0\mu$   
*Xylaria polymorpha* (Pers.) Greville  
 51' Stromata linear cylindric,  $2\cdot5-3\times13-21$  mm; ectostroma in long plaques; perithecia close crowded; spores crescentic, narrow ended, dark brown, with prominent sheaths,  $6\cdot5-7\cdot0\times15\cdot0-19\cdot0\mu$   
*Xylaria berkeleyi* Montagne  
 52 (50) Perithecial vertices hemispheric, evident in outline.....53  
 52' Perithecia sunken or vaguely evident only.....54  
 53 Ectostroma yellow or dull brown to black, usually in polygonal plaques; clavata stipitate, usually fairly stout; spores crescentic, narrow-ended, medium brown to black, without prominent sheaths,  $4\cdot0-5\cdot0\times9\cdot0-10\cdot5\mu$   
*Xylaria curta* Fries  
 53' Ectostroma dull brown, usually semi-continuous and composed of coarse hyphae; clavata stipitate or sessile, pulvinate to stout cylindric; spores equilateral, broad ended, medium to dark brown, with prominent sheaths,  $5\cdot5\times10\cdot5\mu$   
*Xylaria fioriana* Saccardo  
 53' ' Ectostroma dull brown to black, in small linear plaques, inconspicuous; clavata linear or narrow clavate; spores navicular to crescentic, narrow-ended, medium brown,  $8\cdot0\times19\cdot0\mu$   
*Xylaria bififormis* Lloyd  
 54 (52) Stromata broad clavate, sometimes with pannose base; ectostroma in polygonal crusts; spores gibbous, broad-ended, dark brown  $4\cdot0-6\cdot0\times8\cdot5-10\cdot0\mu$   
*Xylaria castorea* Berkeley  
 54' Stromata linear cylindric,  $1\cdot5-3\times6-38$  mm.....55  
 55 Ectostroma continuous or formed of closely aligned plaques; spores gibbous, broad ended, black, without prominent sheaths,  $4\cdot5\times8\cdot5\mu$   
*Xylaria rhytidophloea* Montagne  
 55' Ectostroma in polygonal or linear crusts; spores gibbous, with broad or narrow ends, dark brown, with prominent sheaths,  $5\cdot0\times10\cdot0\mu$   
*Xylaria rhopaloides* Montagne  
 56 (19) Spores with spiral germ slits.....57  
 56' Germ slits straight.....59  
 57 Ectostroma continuous or nearly so, dull-brown, composed of coarse hyphae; stromata usually robust, linear to cylindric; spores navicular, broad ended, dark brown, with prominent sheaths,  $6\cdot0\times17\cdot5\mu$   
*Xylaria leprosa* Spegazzini  
 57' Ectostroma forming scabrid plaques or closely appressed mycelium.....58  
 58 Ectostroma black; spores navicular to crescentic with narrow ends, dark brown,  $5\cdot5\times16\cdot5\mu$   
*Xylaria acuta* Peck  
 58' Ectostroma yellow ochre, fawn brown or dull brown; spores gibbous to crescentic, narrow ended, dark brown to black,  $6\cdot0-7\cdot0\times13\cdot5-18\cdot5\mu$   
*Xylaria cornudamae* Schweinitz  
 59 (56) Spores appendiculate, gibbous to crescentic, with narrow distal ends, dark brown to black,  $5\cdot0-5\cdot5\times10\cdot0-13\cdot0\mu$ . Stromata slight, less than 2 mm diameter, with scanty ectostroma.  
*Xylaria gracillima* Fries  
 59' Spores not appendiculate.....60  
 60 Basal tissue white or pale grey.....61  
 60' Basal tissue dull yellow; stromata narrow cylindric, sometimes with truncate papillate ostioles; spores oval, equilateral to navicular with narrow acute ends,  $4\cdot5-5\cdot0\times9\cdot0-11\cdot0\mu$   
*Xylaria luteostroma* Lloyd  
 61 Ostioles in the centre of small truncate discs on the stromal surface.....62  
 61' Ostioles not annulate.....64

- 62 Stromal surface wrinkled, subiculum usually coarse shaggy and dull brown; ectostroma fawn brown, turning black with age; ostioles not conspicuous; spores gibbous to crescentic, narrow ended, medium to dark brown,  $4.5-6.5 \times 9.5-13.5 \mu$
- 62' Stromal surface smooth ..... 63  
*Xylaria hypoxylon* Greville
- 63 Stromal surface smooth; subiculum usually smooth, red brown, ectostroma purple grey; ostioles easily seen, surrounded by a white granular deposit; spores navicular to crescentic, broad ended, medium to dark brown,  $4.5 \times 10.0 \mu$   
*Xylaria cristata* Spegazzini
- 63' Stromal surface smooth; subiculum smooth, red-brown, limited in quantity, ectostroma dark brown to black; ostioles not conspicuous; spores gibbous narrow-ended, medium brown,  $5.5 \times 10.5 \mu$ . Stromata linear cylindric, multibranched  
*Xylaria tuberosa* (Pers.) Cooke
- 64 (61) Ectostroma clearly developed at maturity ..... 65
- 64' Ectostroma slight at maturity; stromata robust though narrow; perithecia clearly evident; ostioles simple or in truncate depressions; spores gibbous to navicular narrow-ended, dark brown,  $9.5 \times 24.0 \mu$   
*Xylaria theissenii* Lloyd
- 65 Perithecia evident in outline ..... 66
- 65' Perithecia vaguely evident or immersed ..... 69
- 66 Ectostroma yellow ochre; spores gibbous, with broad or narrow ends, medium brown,  $5.0 \times 11.0 \mu$ ; on beech nuts  
*Xylaria carpophila* Fries
- 66' Ectostroma dull brown; substrate otherwise ..... 66
- 67 Perithecia close crowded and projecting, conic to moriform; stromata variable in size but often massive, cylindro-clavate with several branches; spores navicular, narrow ended, medium brown,  $4-5 \times 8-10 \mu$   
*Xylaria bulbosa* (Pers. ex Fr.) Berkeley & Broome
- 67' Perithecia adjacent, not moriform; stromata of moderate size usually linear . . . 67
- 68 Stipes less than 17 mm long, ectostroma semi-continuous, composed of coarse hyphae; on palm nuts and stems; gibbous to crescentic, with narrow ends, pale to medium brown,  $4.0-4.5 \times 10.0-11.0 \mu$   
*Xylaria ianthino-velutina* Montagne
- 68' Stipes 20—52 mm long, ectostroma in linear plaques of closely appressed hyphae; on dicotyledonous wood; spores crescentic, narrow ended, pale brown,  $4.0 \times 9.5 \mu$   
*Xylaria rickii* (Lloyd) Martin  
syn. *Xylobotryum rickii* Lloyd
- 69 (65) Ectostroma continuous, worn off at random, or partly striate ..... 70
- 69' Ectostroma in distinct plaques ..... 71
- 70' Clavata globose or pulvinate, terminating in a white sterile truncate or lobed apex; ectostroma white, turning black, appressed mattose, continuous; spores crescentic, narrow ended, dark brown,  $4.5 \times 10.5 \mu$   
*Xylaria readeri* Müller
- 70' Clavata spatulate or cylindric; ectostroma dull yellow, worn off at random or merging with the purple grey carbonaceous crust; spores  $3.5 \times 7.0 \mu$   
*Xylaria brasiliensis* (Theiss.) Lloyd
- 71 (69) Ectostroma yellow ochre, plaques polygonal; spores crescentic, mucronate, medium to dark brown,  $7.5-8.0 \times 28.0-29.5 \mu$   
*Xylaria comosa* (Mont.) Fries
- 71' Ectostroma various, plaques linear ..... 72
- 72 Stipe not distinct from the clava, very short; ectostroma scabrid and prominent, yellow to dull pink or brown; stromata small in size; spores navicular to crescentic, narrow ended, medium brown,  $4.0 \times 9.0-9.5 \mu$   
*Xylaria inaequalis* Berkeley & Curtis
- 72' Stipe clearly developed; stromata often branched ..... 73
- 73 Spores  $> 20 \mu$  long ..... 74
- 73' Spores  $< 20 \mu$  long ..... 75

- 74 Ectostroma light yellow or brown; spores gibbous to navicular, narrow ended, medium to dark brown, with prominent sheaths,  $6\cdot0-8\cdot0\times 16\cdot0-24\cdot5\mu$ ; stroma usually linear-cylindric  
*Xylaria apiculata* Cooke
- 74' Ectostroma dull brown; spores navicular to crescentic with narrow or acute ends, medium to dark brown,  $7\cdot0-9\cdot0\times 21\cdot5-27\cdot0\mu$ ; stromata various  
*Xylaria polymorpha* (Pers.) Greville
- 74'' Ectostroma dull brown; spores navicular to crescentic, with narrow or acute ends, medium to dark brown,  $5\cdot0\times 15\cdot5\mu$ ; stromata various but apices often spatulate; parasitic on apple and other deciduous fruit trees  
*Xylaria mali* Fromme
- 75 (73) Stromata on wood.....76
- 75' Stromata occurring on dead grass stems; linear cylindric; ectostroma initially white and remaining partly so at maturity, otherwise turning light brown; spores gibbous, narrow ended, dark brown,  $5\cdot0\times 10\cdot5\mu$   
*Xylaria graminicola* Gerard
- 76 Stipes of the filiform stromata revolute; spores navicular to crescentic, narrow ended, dark brown,  $4\cdot5\times 10\cdot0-10\cdot5\mu$   
*Xylaria scopiformis* Montagne
- 76' Stipes not revolute, stromata more robust.....77
- 77 Stroma; surface smooth, ectostromal plaques elongate.....78
- 77' Stromal surface furrowed, ectostromal plaques short.....80
- 78 Ostioles prominent papillate; spores gibbous, narrow ended, dark brown to black,  $4\cdot5\times 9\cdot0\mu$   
*Xylaria feejeensis* Berkeley
- 78' Ostioles papillate but not conspicuous.....79
- 79 Spores  $4\cdot5-5\cdot0\times 9\cdot5-11\cdot5\mu$   
*Xylaria multiplex* Saccardo
- 79' Spores  $6\cdot0\times 13\cdot0\mu$ , navicular, narrow-ended, dark brown, with prominent gelatinous sheaths  
*Xylaria arbuscula* Saccardo
- 80 (77) Stromata exceedingly long, narrow cylindric, stipes 55 mm, clavata 30 mm; spores crescentic, broad ended, medium brown,  $6\cdot0\times 12\cdot5\mu$   
*Xylaria subterranea* (Schw.) Saccardo
- 80' Stromata narrow cylindric or bulbous, but stipes not exceeding 20 mm and clavata not exceeding 40 mm.....76
- 81 Clavulae cylindric or spatulate, characteristically arising from a stout common base; spores equilateral to gibbous, narrow-ended,  $5\cdot0-6\cdot0\times 10\cdot5-12\cdot5\mu$   
*Xylaria digitata* (Bruck.) Greville
- 81' Stromata normally unbranched, but if so then without a stout basal portion and clavulae linear cylindric.....77
- 82 Stromata cylindric but usually robust; spores gibbous to crescentic, narrow-ended, medium to dark brown,  $4\cdot5-6\cdot5\times 9\cdot5-13\cdot5\mu$   
*Xylaria hypoxylon* Greville var *subtrachelina*  
 syn. *Xylaria subtrachelina* Hennings
- 82' Stromata narrow cylindric, less than 2 mm diam.; spores crescentic, narrow-ended, medium brown,  $5\cdot5\times 13\cdot0\mu$   
*Xylaria bataanensis* Hennings

### Analysis of Species:

#### Section Xyloglossa

##### 1. *Xylaria cubensis* Montagne

Berkeley M. J. Jour. Linn. Soc. **10**, 380, (1869). Dennis R. W. G. Kew Bull. **1956**, 432, (1956). Lloyd C. G. Myc. Writ. **5**, : *Xylaria* Notes I, 4, (1918). Miller J. H. Bothalia **4**, 264, (1942). Montagne J. F. C. Ann. Sci. Nat II **13**, 345, (1840); Syll. Crypt. 202, (1856). Parks H. E. Univ. Calif. Publ. Bot. **12**, 49, (1926). Patouillard N. & A. Guillard Bull. Soc. Myc. de Fr. **4**, 107, (1888). Rehm N. Hedwigia **40**, 145, (1901). sub *Hypoxylon cubensis*. Montagne J. F. C. in Sagra: Hist. Cuba 347, (1838—1842).

Stromata gregarious, globose, obovate or clavate, unbranched or once dichotomous; clavata stout,  $4.0-10 \times 6.8-12.5 \times 18-37$  mm with fertile apices; stipes distinct, smooth,  $1.0-5.5 \times 8.5-38$  mm. Subiculum smooth, dense matted, light brown, hyphae densely branched and closely anastomosed,  $1.8-3.1 \mu$  in diameter. Ectostroma crustose, continuous or minutely cracked, medium brown or dull murky brown, black with age. Entostroma smooth, externally carbonaceous, internally fleshy, solid to involute or longitudinally furrowed, pure white to cream. Perithecia always several per stroma, immersed, adjacent, oval, broader than high,  $600-800 \times 500-700 \mu$ ; ostioles medium papillate. Asci cylindric  $115-135 \times 5-6 \mu$ ; stipes  $67-79 \mu$ . Spores oval, equilateral to gibbous, narrow ended, dark brown to black,  $3.5-5.0 \times 7.0-9.0 \mu$ , ave.  $4.0 \times 7.8 \mu$ .

*Material examined:*

Maguire in NYBG Tropical Expedition to Surinam 24168F; in montane forest, Coppernam River, Surinam, (1944), (NYBG). Martin 1780 ex Carroll 142; Puerto Viejo, Costa Rica, (1962). Rick 384; Porto Novo, Santa Catherina, Brazil, (1928), (NYBG). Thaxter in Miller 8782; Burbank, Tenn., U.S.A., (1896), (NYBG).

Cultural characters (Plate V:14):

Colonies felty to floccose, with coarse texture, uniform, aerial mycelium pure white to pink. Margin distinct, lobed, hyphae compact. Carbonization absent. Growth rate rapid,  $4.3$  mm/day at  $25^\circ\text{C}$ .

Coremia unbranched, straight, clavate to spatulate, without dark mycelium, white at apices,  $0.8-2.0 \times 3.5-17$  mm. No conidia observed.

Microscopic characters:

Primary mycelium undiagnostic; maximum diameter of the marginal hyphae  $= 1.2 \mu$ . Secondary mycelium loose,  $1.8-2.5 \mu$  in diameter.

2. *Xylaria myosurus* Montagne

Dennis R. W. G. Kew Bull. 1956, 411, (1956). Lloyd C. G. Myc. Writ. 6, 911, (1920), Montagne J. F. C. Ann. Sci. Nat. IV 3, 110, (1855); Syll. Crypt. 206, (1856). Saccardo P. A. Syll. Fung. 1, 311, (1882). Theissen F. Denk. Akad. Wiss. Wien math-naturw. Klasse 83, 56, (1927). Van der Bijl P. Trans. Roy. Soc. S. Afr. 9, 181, (1921).

Stromata solitary, unbranched, clavate,  $6.0-8.5 \times 6.5-9.5 \times 20-25$  mm, with fertile apices; stipes distinct, dull brown, smooth,  $2.5-3.0 \times 12-13$  mm. Subiculum smooth, dense matted, dull brown; hyphae closely reticulate,  $3.7-4.5 \mu$  in diameter. Ectostroma continuous except for minute cracks, burgundy brown. Entostroma smooth, externally black and carbonaceous, internally fleshy, pure white, solid. Perithecia always several per stroma, immersed, adjacent, oval,  $400-500 \times 500-600 \mu$ ; ostioles medium papillate. Asci not seen. Spores gibbous, to crescentic with narrow ends, dark brown,  $3.5-5.5 \times 6.0-13.0 \mu$ , ave.  $4.5 \times 10.1 \mu$ .

*Material examined:*

Lapitan 500 in USDA Mycol. Coll. 71555; on *Strombosia philippinensis*, Mt. Makiling, Laguna, Philippines, (1946), (NYBG). Martin 648 ex Batista; Amazon forest, Brazil, (1961). Martin 1506; San Blas, Nayarit, Mexico, (1962).

## Cultural characters (Plate IV:7; Plate V:13):

Colonies velvet felty to floccose, with fine texture, uniform, pure white. Margin distinct, lobed; hyphae compact. Carbonization slight. Growth rate moderate, 2·8 mm/day.

Coremia unbranched, straight, clavate, initially pink, later smoky; sometimes with basal dark mycelium, and with clavate, ochre brown apices, 0·5—1·5 × 4·0—8·0 mm, sterile.

## Microscopic characters:

Primary mycelium undiagnostic; maximum diameter of the marginal hyphae=2·3 $\mu$ . Secondary mycelium loose, 2·2—3·1 $\mu$  in diameter.

Section *Xylorugosa*

A. Stromata pulvinate to cylindric, stipes often ill-differentiated; conidiophores developed irregularly as well as in palisade formation, coremia straight aristate or variously shaped.

3. *Xylaria berterii* (Mont.) Cooke (Plate II:5; Fig. I:1)

sub *Hypoxylina peltata* Lloyd C. G. Myc. Writ. 1, 1315, (1924).

sub *Hypoxyton berterii* Montagne

Hennings P. Hedwiga 36, 229, (1897). Montagne J. F. C. in Gay: Hist. Chile VII, 438, (1850); Syll. Crypt. 211, (1856). Rick, J. Ann. Mycol. 5, 28, (1907). Theissen F. Ann. Mycol. 6, 345, (1908); Ibid 7, 151, (1909).

sub *Hypoxyton heinricheri* Bresadola G. Ann. Mycol. 5, 241, (1907).

sub *Sphaeria berterii* Montagne J. F. C. Ann. Sci. Nat. II, 3, 353, (1835).

sub *Xylaria berterii* (Mont.) Cooke Starback K. Bih. Svenska vat. akad. handl. 27, (9) 15, (1901). Cooke M. C. Grevillea 11, 126, (1883).

Stromata aplano—pulvinate, 4—15 × 8·5—19 × 3·8—5·2 mm, often divided into 2 or 3 lobes, normally erumpent through bark from the wood beneath, and sessile or slightly stipitate, depending on whether the latter is hard or soft, but occasionally superficial on exposed areas of wood from which the bark has cracked away formerly. Ectostroma corky when young, later scabrous and breaking into roughly polygonal crusts. Entostroma carbonous above the perithecia, fleshy and white beneath, sometimes with large cavities; decaying shortly after maturity to leave a large hollow space beneath the perithecia. Perithecia situated at the periphery of the stroma, immersed, broadly globose with thick walls, 1000—1200 × 600—900 $\mu$ ; ostioles distinctly papillate. Asci long cylindric, 90—160 × 6—9 $\mu$ ; stipes 40—110 $\mu$ . Spores broadly oval, equilateral, with rounded ends, dark brown to black, 3·5—8·5 × 8·0—14·5 $\mu$ , ave. 5·6 × 11·3 $\mu$ .

South African hosts: *Olea capensis* (preferred), *Curtisia faginea*, *Maytenus buxifolia* and *Rhus legati*.

*Material examined:*

Martin 38, 48, 49, 85, 102, 128, 284, 366, 503, 1185; Nature's Valley, Western Cape, South Africa, (1958, 1959, 1962).

Cultural characters (Plate IV:2; Plate V:5):

Colonies velvet fleecy, white, smooth opaque, uniform; margin distinct, entire or lobed, canescent, compact. Carbonization extensive, beginning after 20 days. Coremioid growths are regularly produced, a minority of these developing pale grey conidia. Growth rate moderate, 3.6 mm/day at 20°C. optimum temperature.

Microscopic characters (Fig. II:1):

Primary mycelium undiagnostic, maximum diameter of the marginal hyphae—2.7 $\mu$ . Secondary mycelium loose to reticulate, of long branched hyphae 2.1—3.4 $\mu$  diameter.

Conidiophores and conida (Fig. II:6, 7):

The coremia vary greatly in size according to the environment: in bottle culture they are large, up to 2 cm long and 1 cm wide, irregular in shape but normally cylindric or coniform, branched once or twice. In plate culture they are much smaller, 1—3 $\times$ 5—7 mm, aristate or clavate, and unbranched or forked. The base of the coremium is dark superficially, while the distal part is white or pink, and fertile. The interior is composed of white fleshy tightly packed pseudoparenchymatous tissue.

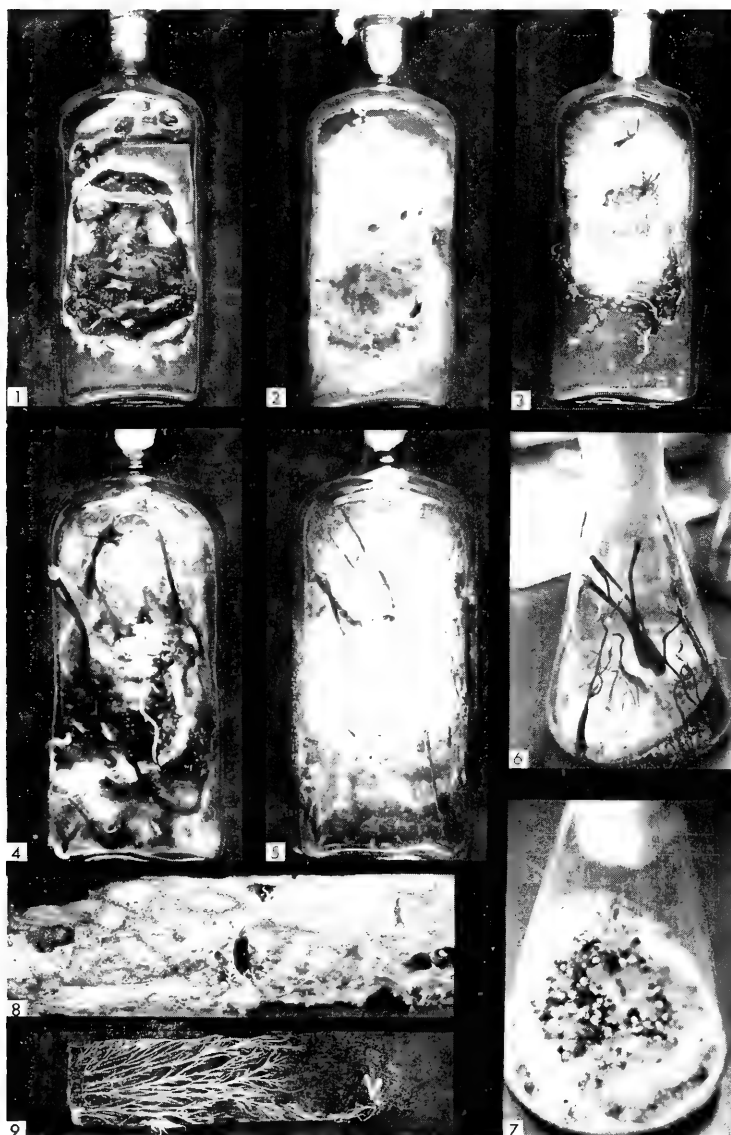
The conidiophores are in palisade formation but are irregularly arranged. They are dichotomously or ternately branched to the first or second degree, but do not continue indefinitely as in *K. deusta*; 40—60 $\times$ 1.1—1.9 $\mu$ . The fertile hyphae are partly irregular in outline, terete or bulbous, 50—2.0 $\times$ 1.1—3.5 $\mu$ . The conidia are pleuracrogenous, oval or elliptic, pale grey collectively, 1.4—2.3 $\times$ 3.7—7.6 $\mu$ , ave. 1.7 $\times$ 4.5 $\mu$ .

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PLATE IV. Cultural Characters

- 1—7. Bottle cultures all on malt agar 2 weeks at 25°C unless otherwise stated
- 8—9. Wood cultures: Water-saturated wood at 25°C for 2 weeks
  1. *Kretzschmaria deusta*: on Czapek, showing extreme carbonization and distortion of medium
  2. *Xylaria berteri*
  3. *Xylaria fioriana*: Conidia arising from coremia and direct from flat mycelium
  4. *Xylaria castorea*
  5. *Xylaria leprosa*
  6. *Xylaria multiplex*
  7. *Xylaria myosurus*
  8. *Xylaria fioriana*: coremia simulating young stromata  $\times$ (1)
  9. *Podosordaria plumosa*: mycelial tassels  $\times$ (1)





This species is also hard to classify, having some of the stromal characteristics of the Entoleuca section of *Hypoxylon* (*H. discolor* etc.) and others of a true *Xylaria*. It is probably closer to *Xylaria* on account of the typical coremia and general cultural characters.

4. *Xylaria enteroleuca* (Spegazzini) Martin nov. comb.

sub *Hypoxylon enteroleucum* Spegazzini non Kickx

Spegazzini C. Anal. mus. nac. Buenos Aires 6, 264, (1899).

sub *Penzigia enteroleuca* (Speg.) Miller

Chardon C. E. et al. Mycologia 32, 183, (1940). Miller J. H. World Species of *Hypoxylon* 133, (1961).

sub *Nummularia enteroleuca* (Speg.) Patouillard N. Bull. Soc. Myc. de Fr. 22, 56, (1906).

Stromata oval, pulvinate or aplanopulvinate, close together,  $3.0-7.0 \times 5.0-35 \times 1.5-17$  mm, unbranched, sessile but attached at a central point to the substrate. Ectostroma forming polygonal crusts, smooth or verrucose, black; entostroma smooth, externally black and carbonaceous, internally pure white and fleshy, solid, but usually concave on the underside. Perithecia always several per stroma, immersed; adjacent, oval,  $700-800 \times 800-900\mu$ , ostioles medium papillate. Asci cylindric,  $130-165 \times 8-9\mu$ ; stipes  $60-84\mu$ . Spores oval, equilateral or gibbous with narrow ends, black,  $5.0-9.5 \times 9.5-16.5\mu$ , ave.  $6.7 \times 12.5\mu$ .

Material examined:

Martin 1794 ex Carroll 172; University of Costa Rica Botanical Garden, San Pedro, Costa Rica, (1962). Teng 3292; Huna Forest, Kiulungshien, Sikang, China, (1939), (AA). Teng 3513; on *Betula*, Muli, Sikang, China, (1940), (AA).

Cultural characters (Plate V:4; Plate VI:4):

Colonies canescent, appressed, uniform, pure white. Margin not distinct, entire; hyphae compact. Carbonization slight, growth slow, 1.8 mm/day at 25°C.

Coremia unbranched, curved, aristate, clavate or fan shaped, flaring, with dark bases, sterile, or fertile over the apices,  $0.6-1.1 \times 5.5-13$  mm.

Microscopic characters:

Primary mycelium undiagnostic; maximum diameter of the marginal hyphae  $1.2\mu$ . Secondary mycelium uniform, loose,  $1.8-3.7\mu$  in diameter.

Conidiophores and conidia (Plate VII:8):

Conidiophores in palisade formation, rather short,  $28-38 \times 1.2-1.8\mu$ , unbranched or branched dichotomously to the first degree at the apices. Fertile branches swollen, elliptic, with distinct globose heads, lying freely,  $4.3-5.0 \times 2.5-3.8\mu$ . Conidia acrogenous, sessile, somewhat thick-walled, clavate with narrow bases, fawn brown en masse,  $1.5-2.5 \times 3.1 \times 4.3\mu$ , ave.  $1.6 \times 3.8\mu$ .

This species is similar to *X. berteri*, differing in minor stromal characters, and in the slower growth rate in culture.

5. *Xylaria fioriana* Saccardo (Plate II:15; Fig. I:3, 4).

Saccardo P. A. Ann. Mycol. **8**, 337, (1910); Syll. Fung. **22**, 350, (1913).

Stromata gregarious or close together, rarely solitary, typically unbranched but sometimes with up to 4 branches; clavata pulvinate, clavate or cylindric,  $2.0-3.0 \times 3.0-5.5 \times 3.0-20$  mm, with fertile apices, attached evenly, at a central point only, or with an indistinct or definite stipe; stipes longitudinally channelled,  $1.5-2.5 \times 0.0-13$  mm. Subiculum smooth, of dense matted hyphae, dull brown; hyphae rosy,  $3.5-4.0 \mu$  in diameter. Ectostroma verrucose, predominantly composed of tomentose rather than crustose hyphae, worn off randomly, without obvious cracks or striations except for possible annulate discs around the ostioles, dull murky brown. Entostroma black and carbonaceous externally, internally white and fleshy, solid. Perithecia always several per stroma, evident completely to vaguely evident, adjacent, globose,  $200-400 \times 300-600 \mu$ ; ostioles minute papillate. Asci cylindric,  $85-130 \times 6-8 \mu$ ; stipes  $16-39 \mu$ . Spores oval, equilateral, with broad ends, subhyaline to translucent, medium to dark brown, with prominent sheaths,  $4.5-7.5 \times 8.0-12.0 \mu$ , ave.  $5.6 \times 10.4 \mu$ .

South African Hosts: *Aloe ferox*, *Aloe pluridens*: dead wood and bark, in dry and exposed as well as moist and shady habitats.

Material examined:

Martin 510; Kariega River near Southwell, E. Cape, South Africa, (1958). Martin 635; Grahamstown, E. Cape, (1962).

Cultural characters (Plate IV:3; Plate V:6):

Colonies velvet felty, with fine texture, zonate with 1 or 2 zones, pure white. Margin distinct, lobed; hyphae compact. Carbonization absent. Growth rate moderate,  $3.7$  mm/day at  $25^\circ\text{C}$ .

The coremia are unbranched, relatively short and stout, straight or curved, aristate, initially pink, later white. At maturity there is dark basal mycelium, the lower part of the coremium is covered by long setose hyphae and the distal area is glabrous, pale grey, often producing many conidia.

Microscopic characters (Fig. II:9):

Primary mycelium undiagnostic; maximum diameter of marginal hyphae  $= 2.1 \mu$ . Secondary mycelium reticulate, vesiculate,  $2.2-6.2 \mu$  in diameter.

Conidiophores and conidia (Plate VII: 9; Fig. II:8):

Conidiophores borne off ordinary mycelium or from the coremia, irregularly

or in palisade formation, the latter usually in coremia found growing in nature,  $76-82 \times 2.5-3.1 \mu$ , branched dichotomously to the second degree distally or over their entire length. Fertile branches narrow, lying freely,  $30-41 \times 2.6-3.6 \mu$ . Conidia acrogenous, borne on slender sterigmata, oval to elliptic, pale grey collectively,  $1.1-1.7 \times 2.3-4.6 \mu$ , ave.  $1.6 \times 3.5 \mu$ .

6. *Xylaria ianthino-velutina* Montagne

Berkeley M. J. Ann. & Mag. Nat. Hist. **10**, 385, (1842). Berkeley M. J. & M. C. Cook. Journ. Linn. Soc. Bot. **15**, 395, (1877). Cooke M. C. Grevillea **11**, 84, (1883). Currey F. Trans. Linn. Soc. Lond. **22**, 264, (1859). Dennis R. W. G. Kew Bull. **1956**, 409, (1956). Von Hohnel F. Denk. Akad. Wiss. Wien math-naturw. Klasse **83**, 28, (1927). Léveillé M. J. H. Ann. de Sci. Nat. Bot. III **3**, 45, (1845) sub *Sphaeria*. Lloyd C. G. Myc. Writ. **7**, 1246, (1924); Ibid **7**, 1251, (1924); Ibid **7**, 1354, (1925). Miller J. H. Monog. Univ. Puerto Rico B **2**, 216, (1934); Bothalia **4**, 266, (1942). Montagne J. F. C. Syll. Crypt. **204**, (1856). Rehm H. Ann. Mycol. **5**, 29, (1907). Spegazzini C. Anal. Soc. Sci. Arg. **18**, 279, (1884). Theissen F. Denk. Akad. Wiss. Wien math-naturw. Klasse **83**, 59, (1809). Viégas A. P. Bragantia **4**, 110, (1944). Van der Bijl P. Trans. Roy. Soc. S. Afr. **9**, 181, (1921).

Stromata gregarious, usually close together, unbranched; clavata cylindric, straight or curved,  $0.7-1.2 \times 0.8-2.0 \times 2-17$  mm, with elongate sterile apices; stipes distinct or weakly differentiated, dull brown, longitudinally channelled,  $0.8-1.1 \times 2-17$  mm. Subiculum rough, dense matted, dull brown; hyphae ropy,  $3.7-6.0 \mu$  in diameter. Ectostroma feebly persistent at maturity, composed of tomentose rather than crustose hyphae, worn off randomly without obvious cracks or striations, dull brown. Entostroma externally black and carbonaceous, internally fleshy and pure white, solid. Perithecia always several per stroma, but strongly resembling the individual perithecia of species formerly placed in *Rosellinia* (*Hypoxylon* section *Entoleuca*), evident completely or above the vertices, set well apart or adjacent, oval, broader than high,  $300-400 \times 200-300 \mu$ ; ostioles medium papillate. Asci cylindric,  $80-90 \times 6-9 \mu$ ; stipes  $24-30 \mu$ . Spores elliptic, with narrow ends, gibbous, navicular or crescentic, pale to medium brown,  $3.0-5.0 \times 9.5-14.5 \mu$ , ave.  $4.2 \times 10.6 \mu$ .

South African hosts:

Nuts and stems of various palms and legumes, including *Cocos*.

Material examined:

Linder 801 in Miller 8843; on legume pod, Bautica, British Guiana, (1924), (NYBG) Martin 1534, 1538, San Blas, Nayarit, Mexico, (1962).

Cultural characters (Plate VI:5):

Colonies velvety, with fine texture, zonate with 1 or 2 zones, pure white. Margin not distinct, entire; hyphae compact. Carbonization absent. Growth rate moderate,  $3.0$  mm/day at  $25^{\circ}\text{C}$ .

Coremia unbranched, straight or curved, aristate, without dark mycelium, white, fertile over apices and sides,  $0.3-0.5 \times 3.5-12$  mm.

## Microscopic characters:

Primary mycelium undiagnostic; maximum diameter of marginal hyphae  $= 2.3\mu$ . Secondary mycelium reticulate,  $2.2-3.1\mu$  in diameter.

## Conidiophores and conidia:

Conidiophores irregular in formation,  $75-390 \times 1.5-1.8\mu$ , branched to the second degree distally, dichotomous or ternate. Fertile branches lying freely, swollen, clavate,  $8.7-15 \times 1.8-4.3\mu$ . Conidia acrogenous, sessile, clavate with narrow bases, cineraceous en masse,  $1.8-2.5 \times 3.7-5.0\mu$ , ave.  $2.0 \times 4.4\mu$ .

8. *Xylaria anisopleura* Montagne

Berkeley M. J. & C. E. Broome Jour. Linn. Soc. Lond. **14**, 119, (1875). Cooke M. C. Handbook of Australian Fungi 286, (1892). Dennis R. W. G. Kew Bull. **1956**, 439, (1956). Fries E. M. Nova act. reg. Soc. Sci. Upsala III, 1, 127, (1851). Hennings P. Hedwigia **43**, 207, (1904). Léveillé M. J. H. Ann. de Sci. Nat. Bot. **III**, 43, (1845). Lloyd C. G. Mycol. Writ. **5**: *Xylaria* Notes II, 24, (1918); *Ibid* **6**, 896, (1919); *Ibid* **7**, 1251, (1924). Miller J. H. Monog. Univ. Puerto Rico B. **2**, 212, (1934); *Bothalia*, **4**, 270, (1942). Montagne J. F. C. Ann. Sci. Nat. II **13**, 348, (1840); Syll. Crypt. 204, (1856). Theissen F. Denk. Akad. Wiss. Wien Math-naturw. Klasse **83**, 67, (1927). Van der Bijl P. Trans Roy. Soc. S. Afr. **9**, 181, (1921).

sub *Hypoxyton apoense* Hennings P. Philip. Sci. **3**, C, 51, (1908); Hedwigia **47**, 259, (1908). Shear C. L. Lloydia **8**, 256, (1945).

sub *Hypoxyton nodulosum* Cooke M. C. Grevillea **11**, 130, (1883).

sub *Kretzschmaria rugosa* Earle F. S. Bull. NY Bot. Gard. **3**, 311, (1905).

sub *Xylaria scruposa* Fries

Berkeley M. J. Journ. Linn. Soc. Lond. **10**, 382, (1869). Dennis W. G. Kew Bull. **1956**, 436, (1956). Fries E. M. Nova acta reg. Soc. Sci. Upsala III **6**, 127, (1851). Lloyd C. G. Myc. Writ. **5**; *Xylaria* Notes II, 23, (1918); *Ibid* **7**, 1180, (1923). Miller J. H. Monog. Univ. Puerto Rico B. **2**, 219, (1934). Saccardo P. A. Sylloge Fungorum **1**, 331, (1882). Sydow H. & P. Leaf. Philipp. Bot. **4**, 1153, (1911). Theissen F. Ann. Mycol. **7**, 351, (1909); Denk. Akad. wiss. Wien math-naturw. klasse **83**, 66, (1927). Viégas A. P. Bragantia **4**, 114, (1944).

sub *Xylaria tuberiformis* Berkeley

Berkeley M. J. Flor. Nov. Zelandica (1853), quoted in other authors cited. Cooke M. C. Handbook of Australian Fungi 288, (1892). Lloyd C. G. Myc. Writ. **5**, 678, (1917). Rehm H. Leaf. Philipp. Bot. **6**, 1945, (1913); *Ibid* **6**, 2272, (1914). Saccardo P. A. Syll. Fung. I, 324, (1882).

Stromata gregarious, unbranched or with up to 7 branches; clavata pulvinate, clavate or cylindric,  $1.8-8.5 \times 2.0-17 \times 1.2-41$  mm, with fertile apices or rarely sterile, acute apices; stipes absent so that stroma is sessile and attached by a central point only, ill-differentiated or distinct,  $0.0-4.0 \times 0.0-30$  mm, smooth or irregularly uneven. The stromata, therefore embrace a wide range of form, including that assigned originally to *Penzigia* as well as the conventional *Xylaria* type. Subiculum rarely absent, smooth, dense matted, light or dull brown or purple brown; hyphae ropy,  $1.5-6.0\mu$  in diameter. Ecstroma usually crustose, sometimes with loose setose hyphae as well, continuous or forming polygonal crusts, dull brown. Entostroma wrinkled, externally black and carbonaceous, internally pure or dull white, cream or dull yellow, fleshy, solid. Perithecia always several per stroma but as low as 4 per clava, immersed,

vaguely evident or with evident vertices, adjacent with vertical, diagonal or horizontal orientation, oval,  $400-800 \times 600-1100\mu$ ; ostioles medium papillate. Asci cylindric,  $185-260 \times 6-11\mu$ . Spores navicular to broad crescentic, rarely gibbous, with narrow or acute ends, and spiral germ slits, sometimes also with prominent sheaths, dark brown,  $6.0-12.0 \times 17.5-32.5\mu$ , ave.  $8.0 \times 23.7\mu$ .

#### Material examined:

##### sub *Hypoxyton apoense*

Copeland 1073; Mt. Apo, Mindanas, Philippines, (1904), (NYBG).

##### sub *Kretzschmaria rugosa* Britton, Britton & Earle 6323, Sierra de Yabucon, Puerto Rico, (1922), (Mill.).

Britton & Cowel 337; Molyneux, St Kitts Island, (1901), (Mill.).

Anon 328; Herb. Insular Expt. Sta., Rio Piedras, Puerto Rico (Mill.).

##### sub *Xylaria anisopleura*

Rick 139; Porto Novo, Santa Catherina, Brazil, (1928), (NYBG). Slout in Gaillard's Plantes du Haute Orenoque 261; France, (1887), (NYBG). Rick 139; Porto Novo, Santa Catherina, Brazil, (1928), (Mill.). Wille 2034; Puerto Rico, (1915), (NYBG). Martin 670 ex Batista; Amazon forest, Brazil, (1961). Martin 1065; ex Schroeder, Turrualba, Costa Rica, (1962). Martin 1539; San Blás, Nayarit, Mexico, (1962). Martin 1784 ex Carroll 147; Puerto Viejo, Costa Rica, (1962). Martin 1785 ex Carroll 148; Dominical, Costa Rica, (1962).

##### sub *Xylaria scruposa*

Duss 80; on *Cereus giganteus*, Guadeloupe, (1900), (NYBG). Jaccoud in Herb OKF 63; San Pedro, Brusque, Santa Catherina State, Brazil, (1955), (Mill.). Rick 389; Porto Novo, Santa Catherina, Brazil, (1928), (NYBG). Roumeguère in Fungi gallici exsicc. 666; Vosges, France, (NYBG). Wiebke 3072; Molokai, Hawaii, (1928), (NYBG).

##### sub *Xylaria tuberiformis*

Heller; Kauai, Hawaii, (1895), (NYBG). Parks 22392; Tiriora, Rarotonga, Cook Islands, (1929), (NYBG).

#### Cultural characters:

Colonies velvety to lanose, with plumose aerial mycelium, uniform, pure white. Margin distinct, lobed; hyphae compact. Carbonization slight. Growth moderate,  $3.1$  mm/day at  $28^{\circ}\text{C}$ . optimum temperature.

Coremia unbranched, straight but spirally twisted, aristate or clavate, with basal dark mycelium only, glabrous, dull brown or black to ochre brown distally; sterile or fertile apically;  $1.1-2.1 \times 17-50$  mm.

#### Microscopic characters:

Primary mycelium undiagnostic; maximum diameter of the marginal hyphae  $=2.5\mu$ . Secondary mycelium ropy,  $3.0-4.5\mu$  in diameter.

#### Conidiophores and conidia (Plate VII:7):

Conidiophores borne irregularly,  $90-150 \times 3.0-6.0\mu$ , axes tinted dull brown, branched dichotomously to the second degree uniformly or distally. Fertile branches narrow, partly serrate to regularly geniculate, lying freely,  $21-72 \times 3.7-6.0\mu$ . Conidia pleuracrogenous, sessile, clavate with narrow bases, dull or dark brown,  $3.7-4.3 \times 7.5-9.3\mu$ , ave.  $3.9 \times 8.3\mu$ .

8. *Xylaria mali* Fromme

Brooks F. T. Plant Diseases 236, (1953). Cooley J. S. J. Agric. Res. **69**, 449—456, (1944); Bot. Rev. **12**, 84 (1946). Fromme F. D. Virginia Agric. Exper. Sta. Tech. Bull. **34**, 6, (1928). Fromme F. D. & F. Schneiderhan Phytopathology **28**, 483—490, (1938). Fromme F. D. & H. E. Thomas Science II **45**, 93, (1917); Journ. Agr. Res. **10**, 163—174, (1919) sub *Xylaria hypoxylon*. Wolf F. A. & R. O. Cromwell Journ. Agr. Res. **9**, 269—276, (1917) sub *Xylaria hypoxylon*.

Stromata gregarious, unbranched or with up to 6 clavata; clavata spatulate, 4.0—4.5 × 4.0—9.0 × 9.0—41 mm with flaring sterile apices; stipes ill-differentiated, smooth, 10—11 × 12—13 mm. Subiculum smooth and even, dense matted, red brown, reticulate, 2.9—3.1 μ in diameter. Ectostroma crustose, continuous or in long indefinite plaques, at first white, saffron yellow, or deep orange, later dull murky brown. Entostroma wrinkled, externally black and carbonaceous, internally dull yellow and fleshy, solid. Perithecia always several per stroma, evident at the vertices, adjacent, 350—400 × 500—600 μ; ostioles indistinct papillate. Asci not seen. Spores navicular to broad crescentic, with narrow ends, dark brown, 4.5—5.5 × 13.5—17.5 μ, ave. 5.0 × 15.6 μ.

## Material examined:

Jackson; on *Pyrus malus*, Virginia, U.S.A., (1917), (NYBG). Martin 628; culture only ex Barnett & Stipes, Morgantown, W. Va., U.S.A., (1961). Morgan 650; Ohio, (? Date), (NYBG).

## Imperfect stage:

Fromme F. D. (1920), Fromme F. D. & H. E. Thomas (1917, 1919); Wolf F. A. & R. O. Cromwell (1917), loc. cit.

Colonies velvet-felty, with fine texture, uniform, dull or pure white. Margin distinct, entire or lobed; hyphae compact. Carbonization absent to extensive. Growth rate moderate, 2.6 mm/day at 25°C.

Coremia unbranched to bifurcate, curved, spatulate, with dark basal mycelium only, initially pink, 1.0—2.4 × 3.0—32 mm. No conidia have been observed.

Wolf & Cromwell describe them as typical for *Xylaria*, hyaline, elongate oval, measuring about 3—3.5 × 10 μ. The coremia obtained by these authors were more massive in size, stout and twisted, hirsute, 4—6 cm long, grey violet or green along their length and flesh coloured at the apices.

9. *Xylaria polymorpha* (Pers.) Breville

Berkeley M. J. in Smith J. E.: English Flora **5**, (2), 234, (1836); Hooker's Journ. of Bot. **3**, 205, (1851); Journ. Linn. Soc. Lond. **10**, 379, (1869); Ibid **13**, 177, (1873); Grevillea **4**, 48, (1875); Journ. Linn. Soc. Lond. **14**, 117, (1875). Berkeley M. J. & C. E. Broome Trans. Linn. Soc. Lond. II, **1**, 405, (1879). Berkeley M. J. & M. C. Cooke Journ. Linn. Soc. Bot. **15**, 395, (1877). Bizzozero G. Flora veneta critt. **1**, 197, (1885). Brefeld O. Untersuch. aus dem Gesamtgebiete der Myk. X, Ascomycetes **2**, 262, (1862). Bresadola G. & P. A. Saccardo Malpighia **4**, 301, (1890). Cesati V. Atti. R. Accad. Scienze Fisiche e Matem. **8**,

- 16, (1879). Chardon C. E. Bol. Real. Soc. Espana Hist. Nat. **28**, 121, (1928). Cooke M. C. Handbook of British Fungi II, 789, (1871); Handbook of Australian Fungi 285, (1892). Corda A. K. J. Icones Fungorum V, 75, (1842). Currey F. Trans. Linn. Soc. Lond. **22**, 263, (1859). Dennis R. W. G. Kew Bull. **1956**, 438, (1956); British Cup Fungi, 180, (1960), sub *Xylophaera*. Ellis T. B. & B. M. Everhart Journ. Mycol. **3**, 99, (1887); N. Amer. Pyren. **665**, (1892). Ferdinandsen C. & O. Winge Mykologiske Ekskursionsflora 399, (1943). Fromme F. D. Virginia Agr. Exper. Sta. Tech. Bull. **34**, 12—13, (1928). Fromme F. D. & H. E. Thomas Science II, **45**, (1917); Journ. Agr. Res. **10**, 163—174, (1919). Fuckel L. Symb. Myc. **238**, (1869—1870). Greville R. K. Flora edinensis **355**, (1824); Scottish Crypt. Flor. **4**, 237, (1826). Gwynne-Vaughan H. C. I. & B. F. Barnes Structure & Development of the Fungi 269, (1937). Hawkins S. Proc. Indiana Acad. Sci. **35**, 227, (1925). Hennings P. Bot. Jahrb. **14**, 368, (1892); Hedwigia **32**, 224, (1893); Bot. Jahrb. **17**, 79, (1895); Abh. Bot. Verh. Prov. Brand. **40**, 160, (1898); Hedwigia **42**, (83), (1903); Ibid **43**, 207, (1904). Von Hohenel F. Denk. Akad. wiss. Wien math-naturw. klasse **83**, 27, (1927). Hébert E. E. Journ. Agr. Res. **29**, 523—567, (1924). Jacewski A. L. Bull. Soc. Myc. de France **11**, 132, (1895). Karsten P. A. Mycologia Fennica II, 36, (1873). Kickx T. Flora Crypt. Flandres 309, (1867). Lambotte E. Flora mycol. belge 428, (1880). Lloyd C. G. Myc. Writ. **7**, 1218, (1923); Ibid **7**, 1353, (1925). Miller J. H. Mycologia **20**, 202, (1928); Bothalia **4**, 270, (1942). Nitschke T. Pyren. Germ. **1**, 16, (1867). Quélet L. Champ. Jura et Vosges 487, (1875). Rabenhorst L. Kryptoflor. Deutsch. II, 878, (1887). Rehm H. Berichte Naturh. Ver. Augsburg **26**, 104, (1881); Hedwigia **21**, 135, (1882); Ibid **40**, 146, (1901). Saccardo P. A. Sylloge Fungorum **1**, 309, (1882); Fungi Ital. **580**, (1877—1886); Ann. Mycol. **4**, 74, (1906). Spegazzini C. Aust. Soc. Scient. Arg. **18**, 277, (1884); Bol. Acad. Nac. Cienc. Cordoba **11**, 512, (1889). Stårback K. Bih. Svenska vet-akad. Handl. **27**, 21 (1901). Van der Bijl P. Trans. Roy. Soc. S. Afr. **9**, 181, (1921). Weir J. R. Phytopath. **7**, 223—224, (1917).
- sub *Sphaeria polymorpha* Persoon  
 Albertini J. D. & L. D. de Schweinitz Conspectus fungorum Lusitiae **3**, (1805). Fries E. M. Syst. Mycol. **326**, (1823). Gray S. F. Natural arrangement of British Plants 512, (1821). Hooker W. J. Flora Scotica II, **4**, (1821). Junghuhn F. H. Praemissa fl. crypt. Javae **23**, (1838).

Stromata gregarious, unbranched or with up to 3 clavata; clavata clavate, pulvinate, cylindric or spatulate,  $1.4\text{--}15 \times 2.2\text{--}17 \times 1.8\text{--}34$  mm with fertile or sterile apices; stipes ill-differentiated to distinct,  $0.7\text{--}9.0 \times 1.0\text{--}65$  mm, smooth or longitudinally channelled. Subiculum smooth and even, dense matted, dull brown to red brown; hyphae loose to ropy or reticulate,  $2.5\text{--}5.6$   $\mu$  in diameter. Ectostroma continuous or in long indefinite plaques, dull brown. Entostroma wrinkled, black and carbonaceous externally, fleshy and pure white to dull yellow internally, solid. Perithecia always several per stroma, adjacent, vaguely evident to immersed, oval or globose,  $400\text{--}800 \times 700\text{--}1000$   $\mu$ ; ostioles medium or indistinct papillate. Asci cylindric,  $205\text{--}265 \times 8\text{--}11$   $\mu$ ; stipes  $48\text{--}109$   $\mu$ . Spores navicular to crescentic, occasionally gibbous with narrow or acute ends, medium to dark brown, with short or elongate linear germ slits,  $5.5\text{--}10.5 \times 20.0\text{--}29.5$   $\mu$ , ave.  $7.7 \times 24.7$   $\mu$ .

#### Material examined:

Everhart & Haines, Westchester, Pa., U.S.A., (1883), (NYBG). Kramer in University of Kansas SC Herb. **19**; Leavenworth Co., Kansas, U.S.A. (1958). Martin 629; culture only ex Barnett & Stipes, Morgantown, W. Va., U.S.A., (1961). Martin 1541; San Blas, Nayarit, Mexico, (1962). Martin 1649; Roxbury, Conn., U.S.A., (1963). Martin 1689; Conway State Forest, Mass., U.S.A., (1963). Martin 1710; Mt. Toby, Mass., U.S.A., (1963). Martin 1782, 1783 ex Carroll 144 & 145; Puerto Viejo, Costa Rica, (1962). Martin 1823 ex Kramer; Douglas Co., Kansas, U.S.A., (1954). Voss & Magnus in Rehm's Ascomyceten **427**; auf Birkenstümpfen, Berlin (1886), (NYBG).



Cultural characters (Plate VI:11). See also Martin (1967), (Plate V:3):

Colonies floccose, with coarse texture, uniform, pure white. Margin distinct, entire; hyphae compact. Carbonization absent. Growth rapid, atypical for a *Xylaria*, 10.0 mm/day at 25°C.

Coremia clavate to spatulate, also straight aristate, with dark basal mycelium only, pale grey to black axes and white globose or flaring heads, 1.2—2.8 × 20—30 mm. No conidia were observed.

Microscopic characters:

Primary mycelium undiagnostic, maximum diameter of the marginal hyphae = 3.8 μ. Secondary mycelium absent.

Imperfect stage:

Brefeld O. (1891), Chardon C. E. (1928), loc. cit. Guèguen F. Bull. Soc. Myc. de Fr. 25, 89—97, (1909). Hubert E. E. Journ. Agr. Res. 29, 523—567, (1924).

Brefeld illustrates a typically irregular conidiophore with large conidia, 6—7 × 10—13 μ.

#### 10. *Xylaria curta* Fries

Dennis R. W. G. Kew Bulletin 1956, 435, (1956). Fries E. M. Nova acta regiae soc. scient. Upsala III 1, 110, (1851). Lloyd C. G. Myc. Writ. 7, 1354, (1925).

Stromata gregarious, clavate: clavata unbranched, 3.0—7.0 × 4.5—12 × 8.0—35 mm, with fertile apices; stipes ill-differentiated or distinct, smooth, longitudinally channelled or irregularly uneven, 1.1—5.5 × 1.7—19 mm. Subiculum absent or of dense matted hyphae, dull brown; hyphae loose to ropy 2.5—3.8 μ in diameter. Ectostroma crustose, in polygonal plaques, sometimes split away from ostioles leaving ochraceous truncate discs (cf *Annulata* group of *Hypoxylon*); colour yellow ochre becoming dull murky brown to black with age. Entostroma smooth or wrinkled carbonaceous externally, flesh internally and solid to involute, cream to pure white. Perithecia always several per stroma, evident at vertices to completely immersed, adjacent, globose to oval, 500—800 × 600—800 μ; ostioles papillate, conspicuous to very small. Asci cylindric, 95—185 × 4—6 μ; stipes 23—120 μ. Spores crescentic, narrow-ended, medium brown to black, 3.0—5.0 × 8.0—12.0 μ, ave. 4.2 × 9.4 μ.

Material examined:

Fidalgo 59; Jardim Botânico do Rio de Janeiro, Guanabara, Brazil, (1957), (Mill.). Martin 653, 654 ex Batista; Amazon forest, Brazil, (1961). Martin 1777 ex Carroll 150; Puerto Viejo, Costa Rica, (1962). Rick 386; Porto Novo, Santa Catherina, Brazil, (1928), (NYBG). Welden 1124 in Tulane University Herb.; Orizaba, Mexico, (1959), (NYBG).

Cultural characters (Plate V:11; Plate VI:10):

Colonies velvety, plumose, uniform, pure white. Margin distinct, pulmose;

hyphae compact. Carbonization slight. Growth rate moderate, 2.6 mm/day at 20°C. optimum temperature.

Coremia short, unbranched, straight aristate, white, with dark basal mycelium only, fertile over the apices and sides,  $0.4-0.8 \times 2.5-3.5$  mm.

Microscopic characters:

Primary mycelium undiagnostic; maximum diameter of the marginal hyphae  $=1.8\mu$ . Secondary mycelium reticulate, hyphae  $1.8-2.7\mu$  in diameter.

Conidiophores and conidia (Plate VII:12):

Conidiophores irregular or in palisade formation, relatively short,  $26-75 \times 1.5\mu$ , branched dichotomously or ternately to the first or second degree distally or over the apices only of the primary axes. Fertile branches swollen, clavate or elliptic, lying freely or in trident formation,  $3.1-4.3 \times 6.2-16\mu$ . Conidia acrogenous, rather thick walled, on slender sterigmata, narrow clavate, cinereous grey en masse,  $2.5-3.8 \times 5.6-8.8\mu$ , ave.  $3.4 \times 6.9\mu$ .

#### 11. *Xylaria cornudamae* (Schw.) Berkeley

Berkeley M. J. *Grevillea* 4, 48, (1875). Ellis J. B. & B. M. Everhart *Journ. Mycol.* 3, 109, (1887); N. Amer. *Pyren.* 673, (1892). Fromme F. D. *Virginia Agr. Exper. Sta. Tech. Bull.* 34, 12-13, (1928); *Journ. Agr. Res.* 10, 163-174, (1919). Lloyd C. G. *Myc. Writ.* 7, 1250, (1924). Rick J. *Ann. Mycol.* 5, 337, (1907). Saccardo P. A. *Syll. Fung.* 1, 338, (1882). Theissen F. *Ann. Mycol.* 7, 351, (1909).  
sub *Sphaeria cornudamae* Schweinitz L. v. D. *Trans. Amer. Phil. Soc. Philad.* NS 4, 189, (1832).

Stromata clavate to cylindric, unbranched to once dichotomous, usually separate but definitely gregarious; clavata  $2.0-7.5 \times 3.0-8.0 \times 12-54$  mm; apices fertile or sterile and short umbonate; stipes longitudinally channelled or smooth,  $1.5-5.0 \times 5.5-5.5$  mm. Subiculum dense matted, dull brown, ropy; hyphae  $3.0-4.5\mu$  in diameter. Ectostroma in broad polygonal or linear crusts, white yellow ochre, fawn brown, purple brown, or dull brown. Entostroma wrinkled, carbonaceous externally, fleshy and pure white internally. Perithecia always several per stroma, vaguely evident, globose to oval, close crowded or merely adjacent,  $400-700 \times 600-900$ ; ostioles medium papillate. Asci cylindric,  $155-215 \times 6-9\mu$ ; stipes  $66-114\mu$ . Spores chiefly broad crescentic but also gibbous or navicular, with narrow, rarely broad, ends, and with spiral germ slits, dark brown to black,  $5.0-8.0 \times 12.0-20.5\mu$ , ave.  $6.1 \times 16.3\mu$ .

Material examined:

Dearness 377d; Canada (details absent), (NYBG). Godfrey; Tuckasegee River, N.C., U.S.A., (1951), (NYBG). Martin 1708, 1709, 1711; Mt. Toby, Mass., U.S.A., (1963). Martin 1740; Conway State Forest, Mass., U.S.A., (1963). Morgan; Ohio, U.S.A., (1886), (NYBG). Thaxter in Miller 8763; on Cranberry, N.C., U.S.A., (1887), (NYBG).

Cultural characters (See Martin (1967) Plate III:6):

Colonies at first submersed, later canescent to felty, with gelatinous aspects. Aerial mycelium, pure white, appressed to plumose, strongly zonate, (rarely uniform) with up to 4 zones. Margin not distinct, entire or segmented, often plumose, hyphae compact. Carbonization absent or slight. Growth rate slow,  $1.1-1.4$  mm/day at  $25^{\circ}\text{C}$ .

Coremia unbranched or dichotomous, straight, aristate to clavate, without dark mycelium and with white or brown apices,  $0.3-0.9 \times 7-17$  mm; fertile over sides only.

Microscopic characters:

Primary mycelium undiagnostic; maximum diameter of marginal hyphae  $=1.5\mu$ . Secondary mycelium loose, uniform,  $2.2-3.0\mu$  in diameter.

Imperfect stage (Plate VII:10):

Fromme F. D. loc. cit.

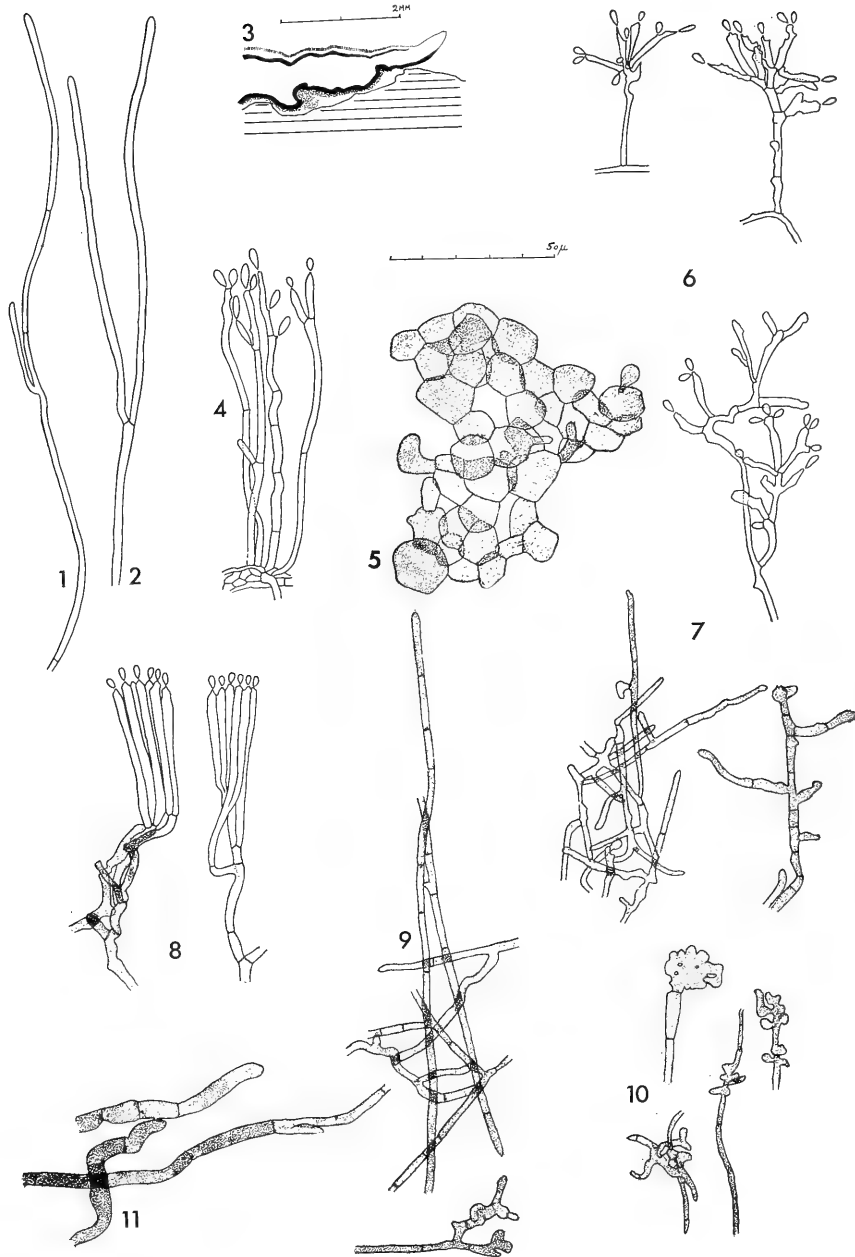
Conidiophores produced in irregular or palisade formation, tinted olivaceous, branched to the first or second degree distally or at the apices only, with up to 4 branches arising from the same point,  $70-140 \times 1.5\mu$ . Fertile branches swollen, clavate or elliptic, lying freely,  $3.1-6.3 \times 7.5-30\mu$ . Conidia acrogenous, somewhat thickwalled, borne on narrow sterigmata, short or long clavate with narrow bases, dull brown,  $2.7-3.1 \times 5.0-8.7\mu$ , ave.  $3.1 \times 6.8\mu$ .

B. Stromata stipitate, not polymorphic; conidiophores in palisade formation only, coremia typically aristate and dark coloured.

## 12. *Xylaria apiculata* Cooke (Fig. I:5).

Cooke M. C. *Grevillea* **8**, 66, (1879). Dennis R. W. G. *Kew Bull* **1956**, 421, (1956). Lloyd C. G. *Mycol. Writ.* **5**, 676, (1917); *Ibid: Xylaria Notes II*, 20, (1918); *Ibid* **6**, 970, (1920); *Ibid* **7**, 1119, (1922); *Ibid* **7**, 1218, (1923). Petch T. *Ann. Roy. bot. gard. Perad.* **8**, 124, (1924). Ruehle G. D. *Phytopath.* **31**, 936-939, (1941). Spegazzini C. *Ann. mus. nac. Buenos Aires* **6**, 260, (1899). Theissen F. *Ann. Mycol.* **7**, 350, (1909); *Denk. Akad. Wiss. Wien math-naturw. klasse* **83**, 61 (1927). Van der Bijl P. *Trans. Roy. Soc. S. Afr.* **9**, 181, (1921). Viégas A. P. *Bragantia* **4**, 108, (1944).

Stromata usually gregarious, clavata pulvinate to cylindric, or coniform, with short acuminate sterile apices,  $1.2-3.0 \times 1.5-2.5 \times 1.8-35$  mm; stipes distinct, short to elongate, black or dull brown, longitudinally channelled,  $0.4-1.0 \times 1.5-30$  mm. Subiculum rough, dense matted to sparse setose, dull brown, ropy, hyphae  $3.7-6\mu$  diam. Initial layer of clava cream; later ecto-



stroma turns yellow gold, buff, fawn or dull brown, crustose, splitting in linear crusts and often feebly persistent. Surface of stroma wrinkled or smooth; outer entostroma carbonaceous, inner fleshy, white. Perithecia 4 to several per stroma, evident at vertices to completely immersed, globose to oval,  $500-1000 \times 600-1000 \mu$ ; ostioles medium papillate. Asci cylindric,  $95-270 \times 7-13 \mu$ ; stipes  $27-138 \mu$ . Spores gibbous to navicular, narrow ended, with prominent sheaths, medium to dark brown,  $5.0-10.5 \times 10.5-30.0 \mu$ , ave.  $7.6 \times 10.2 \mu$ .

South African hosts: *Olea capensis*, *Scutia myrtina*

#### Material examined:

Linder 466; Bautica, British Guiana, (1923), (NYBG). Martin 295, 457; Nature's Valley, Western Cape, South Africa, (1958, 1959). Martin 525, 535, 537; Hogsback, nr Alice, E. Cape, South Africa, (1958, 1959). Martin 652 ex Chaves Batista; Amazon forest, Brazil, (1961). Martin 882-885; Arcata, Northern California, U.S.A. (1961). Rick's Fungi austro-americani 279; Sao Leopoldo, Brazil, (1907), (NYBG).

#### Cultural characters (Plate V:7):

Colonies of the typical *Xylaria* format: velvety with fine texture, uniform, pure white. Margin distinct, entire or lobed, hyphae compact. Carbonization extensive. Growth rate moderate, 2.6 mm/day at 25°C.

Coremia sterile, single and unbranched, straight aristate, mostly dark superficially to white apically,  $1.0-2.0 \times 10-25$  mm.

#### Microscopic characters:

Primary mycelium undiagnostic; maximum diameter of marginal hyphae  $=2.1 \mu$ . Secondary mycelium reticulate,  $1.4-3.2 \mu$  in diameter, distinguished

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FIGURE II. Microscopic Characters

- 1-2. Marginal hyphae
  1. *Xylaria berteri*
  2. *Kretzschmaria deusta*
- 3-5. *Kretzschmaria deusta*
  3. Vertical section through young stroma
  - Vertical dots and lines: Conidiophores and conidia (later ectostroma)
  - Solid black: Carbonaceous entostroma
  - White: Fleshy entostroma
  - Irregular lines: dark crustose mycelium
  - Horizontal lines: Wood
4. Conidiophores and conidia
5. Secondary mycelium
- 6-7. *Xylaria berteri*
  6. Conidiophores and conidia
  7. Secondary mycelium
- 8-9. *Xylaria fioriana*
  8. Conidiophores and conidia
  9. Secondary mycelium
10. *Xylaria arbuscula*: Secondary mycelium
11. *Podosordaria plumosa*: Secondary mycelium

by the production of small club-shaped side-branches, some of which swell and become carbonous (cf *Hypoxylon truncatum*).

### 13. *Xylaria arbuscula* Saccardo

Dennis R. W. G. Kew Bull **1956**, 420, (1956). Hennings P. Bot. Jahrb. **14**, 367, (1892); Abh. Bot. Ver. Prov. Brand. **40**, 159, (1898). Lloyd C. G. Mycol. Writ. **5**: *Xylaria* Notes II, 21, (1918). Miller J. H. Monog. Univ. Puerto Rico B **2**, 213, (1934); Bothalia **4**, 265, (1942). Rehm H. Hedwigia **40**, 147 (1901); Ann. Myc. **9**, 4, (1911). Saccardo P. A. Fungi Ital. 583, (1877—1886); Michelia **1**, 249, (1878). Spegazzini C. An. mus. nac. Buenos Aires **6**, 260, (1899). Theissen F. Denk. akad. wiss. Wien math-naturw. klasse **83**, 61, (1927). Traverso J. B. Flora Ital. Crypt. 129, (1906).

Stromata usually gregarious, rather narrow and filiform with abruptly pointed sterile apices; clavata elliptic to cylindric,  $1.0\text{--}2.6 \times 1.0\text{--}2.6 \times 1.5\text{--}10$  mm, stipes longitudinally channelled,  $0.3\text{--}1.2 \times 2.0\text{--}10$  mm. Subiculum not seen. Ectostroma not conspicuous at maturity, crustose, in linear strands, dull brown. Surface of entostroma wrinkled, black; exterior carbonaceous, interior white fleshy, solid. Perithecia 3 to several per stroma,  $400\text{--}450 \times 450\text{--}550\mu$ ; ostioles medium papillate. Asci cylindric,  $105\text{--}120 \times 6\text{--}8\mu$ ; stipes  $40\text{--}47\mu$ . Spores elliptic, navicular, narrow-ended, with prominent gelatinous sheaths, dark brown,  $4.5\text{--}7.0 \times 10.5\text{--}16.0\mu$ , ave.  $5.4 \times 12.9\mu$ .

South African hosts: Wood unidentified

#### Material examined:

Martin 57, 59; Nature's Valley, Knysna District, Western Cape, South Africa, (1958).

#### Cultural characters (Plate V:9):

Colonies typical for *Xylaria*, velvety, uniform, pure white. Margin distinct, entire or lobed, hyphae compact. Carbonization extensive. Growth rate moderate, 2.2 mm/day at 20°C optimum temperature.

Coremia sterile, single and unbranched, straight aristate, mostly dark superficially but white apically,  $1.0\text{--}2.0 \times 25\text{--}30$  mm.

#### Microscopic characters (Fig. II:10):

Primary mycelium undiagnostic; maximum diameter of marginal hyphae  $= 2.1\mu$ . Secondary mycelium reticulate, dense, with club-shaped branches as in *X. apiculata*,  $1.3\text{--}2.9\mu$  in diameter.

### 14. *Xylaria luteostroma* Lloyd

Lloyd Myc. Writ. **6**, 896, (1919); Ibid **6**, 993, (1920).

Stromata gregarious, unbranched or with up to 8 branches; clavata cylindric, narrow,  $0.9\text{--}3.0 \times 1.2\text{--}5.5 \times 8.5\text{--}48$  mm; apices fertile or sterile and blunt; stipes ill-differentiated or distinct, dull brown, smooth, longitudinally channelled

or irregularly uneven,  $0.8-6.0 \times 3.5-18$  mm. Subiculum sometimes absent; when present rough, dense matted, dull brown or red brown; hyphae loose to rosy,  $2.2-5.0 \mu$  in diameter. Ectostroma crustose, in linear or polygonal crusts, sometimes forming truncate discs around the ostioles as in *X. hypoxylon*, dull brown to black. Entostroma smooth or wrinkled; externally black and carbonaceous, internally dull yellow and fleshy, solid or with cavities. Perithecia always several per stroma, vaguely evident in outline to immersed, adjacent to close crowded,  $300-500 \times 300-600 \mu$ ; ostioles medium or prominent papillate. Asci cylindric,  $125-130 \times 5-6 \mu$ ; stipes  $52-60 \mu$ . Spores equilateral, gibbous or navicular, with narrow or acute ends, dark brown to black,  $3.5-5.5 \times 7.5-12.0 \mu$ , ave.  $4.8 \times 9.8 \mu$ .

#### Material examined:

Baker's Fungi Malayana 300; Mt. Maquiling, Philippines, (1915), (NYBG). Carroll 461; Côte d'Ivoire, (1954). Kramer, in U. of Kansas Sc. Herb 7; Leavenworth, Kansas, U.S.A., (1955). Martin 1513; San Blas, Nayarit, Mexico, (1962). Ramos 1205; Bosoboso, Rizal Luzon, Philippines, (1906), (NYBG).

#### Cultural characters:

Colonies silky to cottony, coarse, uniform, dull white. Margin not distinct, entire; hyphae compact. Carbonization absent. Growth slow,  $2.0$  mm/day. Coremia not formed; sterile.

#### Microscopic characters:

Primary mycelium undiagnostic, maximum diameter of the marginal hyphae  $= 2.5 \mu$ . Secondary mycelium loose,  $3.0-3.8$  mm in diameter.

#### 15. *Xylaria hypoxylon* (Linn. ex Fr.) Greville (Plate II:12):

Baccarini P. Annali di Botanica **14**, 134, (1917). Berkeley M. J. in Smith J. E. English Flora **5** (2), 234, (1836); London Journ. of Bot. **1**, 456, (1842); Ibid **2**, 639, (1843); J. Linn. Soc. **10**, 381, (1869); Ibid **13**, 177, (1873); Greville **4**, 48, (1875); J. Linn. Soc. **16**, 48, (1878). Berkeley M. J. & C. E. Broome J. Linn. Soc. **14**, 119, (1875). Berkeley M. J. & M. C. Cooke Ibid **15**, 395, (1877). Berlèse A. N. & G. Bresadola Ann. Soc. Alp. Trid. **14**, 20, (1887—1888). Bizzozero G. Flora veneta critt. **1**, 198, 1885. Brefeld O. Untersuch. aus dem gesamt. der Myk. X. Ascomyceten **2**, 264, (1891). Bresadola G. & P. A. Saccardo Malpighia **11**, 293, (1897). Cesati V. Atti. R. Accad. Scienze Fisiche de Matem. **8**, 16, (1879). Cooke M. C. Handbook of British Fungi **790**, (1871); Handbook of Australian Fungi **289**, (1892). Currey F. Trans. Linn. Soc. Lond. **22**, 264, (1859). Dennis R. W. G. British Cup Fungi **181**, (1960) sub *Xylosphaera*. Ellis J. B. & B. M. Everhart Journ. Mycol. **3**, 110 (1887); N. Amer. Pyren. **672**, (1892). Ferdinandsen C. & O. Winge Mykologiske Ekskursionsflora **400**, (1943). Fuckel L. Symb. Myc. **238**, (1869—1870). Greville R. K. Flora edinensis **355**, (1824). Guéguen F. Ann. Mycol. **9**, 326—328, (1911). Gwynne-Vaughan H. C. I. & B. F. Barnes Structure and development of the Fungi **269**, (1937). Hawkins S. Proc. Indiana Acad. Sci. **35**, 228, (1925). Hennings P. Bot. Jahrb. **14**, 367, (1892); Bull. Herb. Boiss **1**, 118, (1893); Engler Bot. Jahrb. **22**, 79, (1895); Abh. Bot. Prov. Brand. **40**, 159, (1898); Hedwigia **40**, 340, (1901). Jaczewski A. L. Bull. Soc. Myc. de Fr. **11**, 133, (1895). Junghuhn F. H. Praemissa Flora Crypt. Javae **22**, (1838). Karsten P. A. Mycologia Fennica II. Pyrenomyces **34**, (1873). Kickx J. Flore crypt. Flandres **310**, (1867). Lambotte E. Flore mycol. belge **429**, (1880). Lindau G. in Engler & Prantl: Die natürlichen Pflanzenfamilien **1**, 488, (1897).

Lloyd C. G. Mycol. Writ. 7, 1119, (1922). Miller J. H. Jour. Dept. Agric. Puerto Rico 14, 275, (1930); Monog. Univ. Puerto Rico B 2, 216, (1934); Bothalia 4, 267, (1942). Montagne J. F. C. in Gay: Hist. Cuba VII 430, (1850). Murrill W. A. Mycologia 7, 131—133, (1915). Nitzschke T. Pyren. Germanici: 1, 5, (1867). Rabenhorst L. Krypt. Flor. Deutsch II, 872, (1887). Rehm H. Hedwigia 24, 234, (1885). Saccardo P. A. Fungi Ital. 582, (1877—1886). Syll. Fung. 1, 333, (1882); Ibid 24, 1099, (1930). Schröter J. in Cohn: Krypt. Flor. Schlesien 467, (1908). Spegazzini C. Bol. Acad. Nac. Cienc. Cordoba 11, 511, (1889). Starbäck K. Bih. Svenska Vet. akad. Handl. 15, 8, (1889). Sydow H. & F. Petrak Ann. Mycol. 20, 186, (1926). Sydow H. & P., & E. J. Butler Ibid 9, 418, (1911). Theissen F. Denk. Akad. wiss. Wien math-naturw. klasse 83, 54, (1927). Traverso J. B. Flora Ital. Crypt. 1, 28 (1906). Willdenow C. L. Florae Berolinensis Prodrum 406, (1787).

sub *Clavaria*

Linnaeus C. Flora Suecica II, 457, (1755).

sub *Sphaeria hypoxylon* Linn. ex Fr.

Albertini J. B. & L. D. de Schweinitz Conspectus fung. Lusitiae 2, (1805). Fries E. M. Syst. Mycol. 327, (1823). Hooker W. J. Flora Scotica II, 4, (1821). Persoon C. H. Obs. Mycol. 20, (1796); Comment Fung. Clavae 81, 146, (1797); Syn. meth. fung. 5, (1801—1808).

sub *Xylaria cristulata* Lloyd C. G. Mycol. Writ. 5; *Xylaria* Notes II, 31, (1918).

sub *Xylaria subtrachelina* Hennings

Ferdinandson C. & O. Winge Bot. Tidskrift 29, 18, (1909). Hennings P. Hedwigia 43, 207, (1904). Lloyd C. G. Mycol. Writ. 7, 1121, (1922).

Stromata usually gregarious, with 1—8 clavata, linear to spatulate, occasionally short; clavata spatulate, cylindric, or pulvinate, 1·0—3·0 × 1·5—5·5 × 2·0—43 mm, with flattened sterile apices; stipes often absent, longitudinally channelled, 0·4—3·0 × 0·7—56 mm. Subiculum dull brown or purple brown, ropy, 1·8—5·6 μ in diameter. Ectostroma initially white, later fawn brown to black, persistent, nearly continuous or in linear crusts, smooth or uneven. Entostroma carbonaceous externally, white internally to pale grey. Perithecia 7 to many per stroma, evident or vaguely evident to immersed, 400—750 × 500—800; ostioles small or medium papillate, often in the centre of small truncate discs, sometimes barely perceptible. Asci cylindric, 80—190 × 4—8 μ; stipes 32—90 μ. Spores gibbous, navicular or crescentic, narrow-ended, medium to dark brown, sometimes with visible gelatinous sheaths, 4·0—7·5 × 8·5—15·0 μ, ave. 5·2 × 11·2 μ.

#### Material examined:

Bärhund; Karislojo, Sweden, (1950), (Hel). Ellis; on *Quercus*, Newfield, N.J., U.S.A., (1875), (NYBG). Enkams; Espoo, Nylandia, Sweden (1943), (Hel). Fleming; Arima Valley, Trinidad, (1960), (NYBG). Hisinger; Pojo, Brodorp, Sweden, (1882), (Hel). Malmstrom; Helsingfors, Aggelby, Sweden, (1932), (Hel). Martin 659, 682, 686—688; Yosemite, California, U.S.A., (1961). Martin 732—737; Klamath, N. California, U.S.A., (1961). Martin 781; O'Brien, N. California, U.S.A., (1961). Martin 794, 818, 866, 877—881; Arcata, N. California, U.S.A., (1961). Martin 927; Mazatlan, Sinaloa, Mexico, (1961). Martin 1515, 1540; San Blas, Nayarit, Mexico, (1961). Martin 1738; Conway State Forest, Mass., U.S.A., (1961). Martin 1786, ex Carroll 163; Sor, Denmark, (1962). Martin 1787 ex Carroll 164; Gentofte, Denmark, (1962). Martin 1802 ex Carroll 457; Hareskov, Copenhagen, Denmark, (1963). Martin 1821 ex Kramer; Riley Co., Kansas, U.S.A., (1963). Martin 1828 ex Kramer in U. of Kansas SC. 15; Cofferville, Labette Co., Kansas, U.S.A., (1963). Thaxter in Miller 8832; Waverly, Mass., U.S.A., (1892), (NYBG). sub *Xylaria cristata* Rick, Fungi austro-amer. 281; Sao Leopoldo, Brazil, (1907), (NYBG). sub *Xylaria subtrachelina* Rick, Fungi austro-amer. 238; San Leopoldo, Brazil, (1905), (NYBG).



## Imperfect Stage (Plate V:8, Plate VI:1):

Brefeld O. loc. cit. Cornu M. Ann. Sci. Nat. bot. **6**, 85—86, (1876). Freeman D. L. Ann. Mycol. **8**, 192—211, (1911). Guéguen F. Comptes rendus hebdomadaires des séances de l'Académie des sciences et belles-lettres. **61**, 316—317, (1906); Bull. Soc. Myc. de Fr. **23**, 186—217, (1907). Harder R. Naturw. Zeit. Forst. u. landw. **7**, 429—436, 441—476, (1909). Jaczewski A. L. loc. cit. Lindau G. loc. cit. Traverso J. B. loc. cit.

Colonies velvet felty, with fine or smooth surface, uniform on strongly zonate, pure white, sometimes with yellow discolouration. Margin distinct or not distinct, entire or lobed. Carbonization absent, slight or extensive. Growth rate very slow to moderate, 0.3—2.3 mm/day at 25°C. Coremia often absent; when present unbranched, or with up to 6 branches, straight, aristate or fan-shaped, dark at the base only, with ochraceous apices and the rest white or greyish, 0.3—1.8 × 1.5—44 mm. No conidia observed. Conidial dimensions given in the literature are rather large, reported as 2—3 × 13—15 μ (Brefeld) and 3—4 × 10—15 μ, occasionally up to 25 μ (Guéguen).

## Microscopic characters:

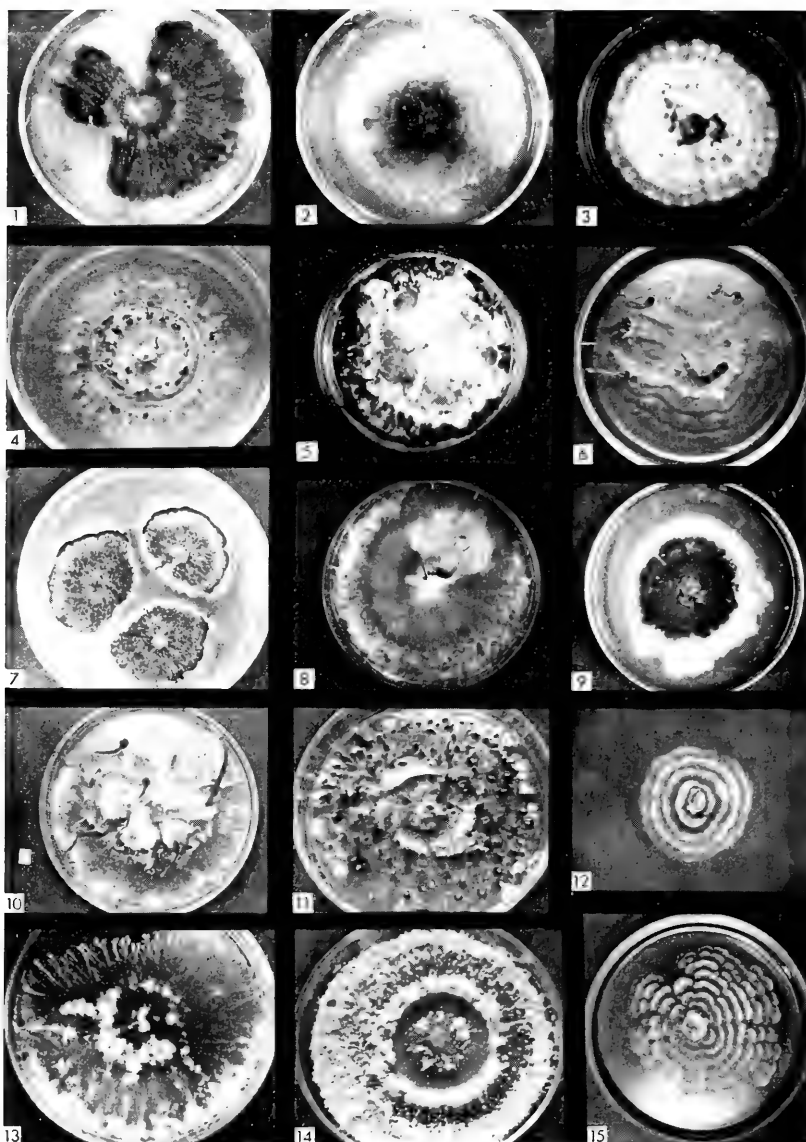
Primary mycelium undiagnostic, maximum diameter of the marginal hyphae = 2.3 μ. Secondary mycelium loose or densely reticulate, uniform or vesiculate, 2.2—4.7 μ in diameter.

16. *Xylaria digitata* (Bruck.) Greville

Berkeley M. J. in Smith J. E.; English Flora **5**, (2), 234, 1836; Ann. & Mag. Nat. Hist. **3**, 397, (1839); Journ. Linn. Soc. **10**, 379, (1869); Grevillea **4**, 48, (1875). Berkeley M. J. & C. E. Broome Journ. Linn. Soc. **14**, 117, (1875). Berkeley M. J. & M. C. Cooke Ibid **15**, 395, (1877). Bizzozero G. Flora veneta critt. **1**, 198, (1885). Cooke M. C. Handbook of British Fungi 789, (1871). Ann. NY Acad. Sci. **1**, 184, (1878); Handbook of Australian Fungi 288, (1892). Currey F. Trans. Linn. Soc. Lond. **22**, 263, (1859). Dennis R. W. G. Kew Bull. **1956**, 412, (1956) sub *Xylosphaera*. Ellis J. B. & B. M. Everhart Journ. Mycol. **3**, 101, (1887); N. Amer. Pyren. 669, (1892). Fuckel L. Symbolae Mycologicae Nachtrag II, 43, (1873). Gray S. F. Natural arrangement of British Plants I, 513, (1821), sub *Hypoxylo*. Greville R. K. Flora edinensis 355, (1824). Hennings P. C. Engler Bot. Jahrb. **14**, 368, (1892); Ibid **17**, 79, (1895); Hedwigia **40**, 341, (1901). Jaczewski A. L. Bull. Soc. Myc. de Fr. **11**, 136, (1895). Kickx J. Flora crypt. Louvain 117, (1835); Flora crypt. Flandres 310, (1867). Lloyd C. G. Myc. Writ. **4**; Letter **60**, 3, (1915); Myc. Writ. **6**, 976, (1920). Massee G. Kew Bull. **1898**, 129, (1898). Miller J. H. Bothalia **4**, 271, (1942). Nitschke T. Pyren. Germ. **1**, 9, (1867). Petch T. Ann. Roy. bot. gard. Perad. **8**, 120, (1924); Naturalist **1939**, 157, (1939). Quélet L. Champ. Jura et Vosges 487, (1875). Rabenhorst G. L. Deutsch. Krypt. flor **1**, 223, (1844). Rabenhorst L. Krypt. flor. Deutsch II, 876, (1877). Schröter J. in Cohn: Kryptoflor. Schlesien 468, (1908). Spegazzini C. Anal. Soc. scient. Arg. **18**, 278, (1884). Traverso J. B. Flora Ital. Crypt. **1**, 25, (1906). Weir J. R. Phytopath. **7**, 223—224, (1917). sub *Sphaeria digitata*

Bolton J. History of Fungusses III, 129, (1780). Bruckmann F. E. Epistola de fungo hypoxilo digitato: Helmstadt, (1725). Fries E. M. Syst. Mycol. 326, (1823); Elenchus Fungorum II, 56, (1828). Junghuhn F. H. Praemissa fl. crypt. Javae 22, (1838). Persoon C. H. Comment Fung. Clavae, 75, 127, (1797); Syn meth. Fung. **6**, (1801—1808). Schrank F. Baierische Flora II, 567, (1789); Ibid III, 351, (1793). Scopoli J. A. Flora carnolica 484, (1772).

Stromata gregarious, spatulate to cylindric, divided into 3—7 clavata; clavata 1.5—2.0 × 1.5—6.5 × 5.5—16 mm, with sterile flaring spatulate



apices, stipes longitudinally channelled, black,  $0.9-3.0 \times 3.0 \times 3.0-11$  mm. Subiculum dull brown, smooth or rough, ropy,  $2.5-3.7\mu$  in diameter. Ectostroma initially white, later sepia to dull brown, splitting in linear crusts, rugose or verrucose. Entostroma carbonaceous outwardly, interior white fleshy. Perithecia always several per stroma, evident at the vertices or only vaguely evident, globose,  $300-400 \times 300-400\mu$  diam.; ostioles small papillate. Asci cylindric,  $90-120 \times 6-7\mu$ ; stipes  $25-43\mu$ . Spores elliptic, equilateral or gibbous with narrow ends, dark brown to black,  $4.0-7.0 \times 8.5-14.0\mu$ , ave.  $5.6 \times 11.6\mu$ .

Material examined:

Kramer in U. of Kansas SC Herb 23; Cherokee Co., Kansas, U.S.A., (1958). Martin 632 ex Plunkett; Mt Palomar, California, U.S.A., (1961). Martin 887; culture ex CBS, Baarn, Holland, (1961). Smith & McClintock 22151 in Herb NYBG R 3790; on *Umbellularia californica*, Muir Woods, California, U.S.A., (1957), (NYBG).

Cultural characters (Plate VI:8):

Colonies velvet to velvet-felty, with fine texture, uniform or with 1 or 2 zones, pure white. Margin distinct, entire or lobed, hyphae compact. Carbonization slight. Growth rate moderate,  $2.7$  mm/day at  $25^\circ\text{C}$ .

Conidiophores and conidia:

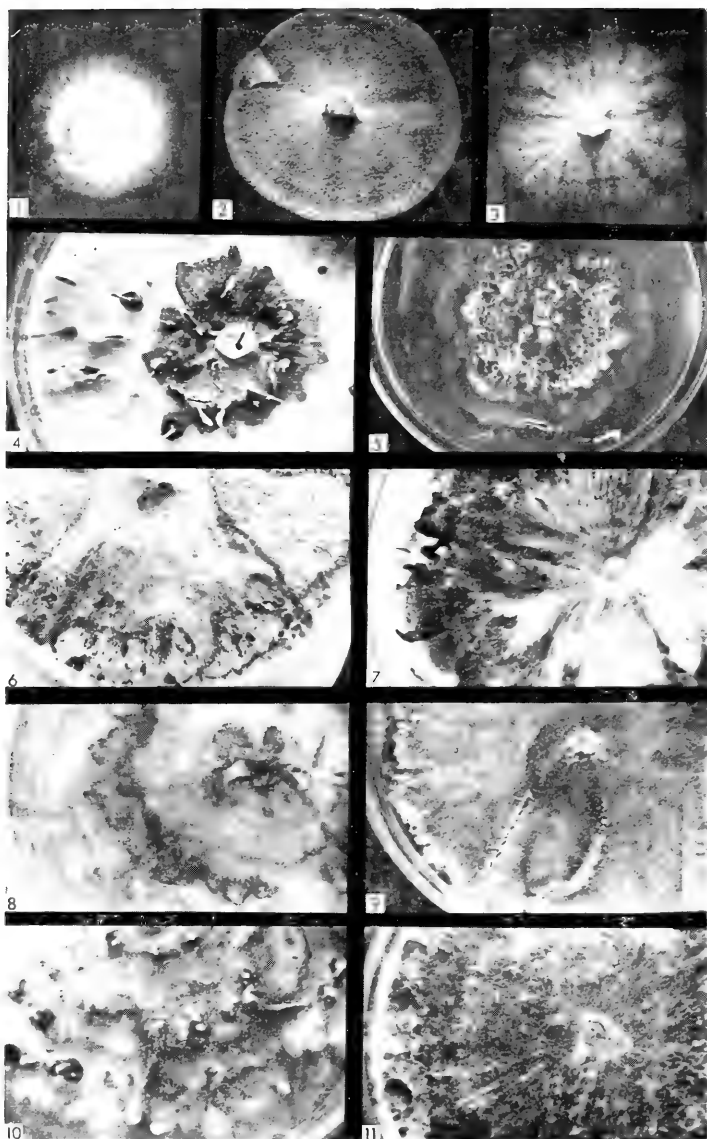
Coremia unbranched, straight aristate, mostly dark superficially but with white apices,  $0.3-1.1 \times 15-58$  mm. Conidiophores irregularly developed, giving a granulate appearance,  $60-460 \times 1.5\mu$ , indefinitely branched, dichotomously or ternately, over the upper parts or apices. Fertile branches smooth, slightly swollen distally,  $6.0-15 \times 1.5\mu$ . Conidia acrogenous, on narrow sterigmata, narrow elongate pyriform, white,  $0.6-0.9 \times 3.7-5.0\mu$ , ave.  $0.7 \times 4.3\mu$ .

This species is doubtfully distinct from *X. hypoxylon*, differing in greater degree of branching of the stroma, and in rapid production of conidia in culture.

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PLATE V. Cultural Characters (*Cont.*). All on malt agar, 2 weeks at  $25^\circ\text{C}$ .

- 1, 2. *Kretzschmaria heliscus*
3. *Kretzschmaria deusta*
4. *Xylaria enteroleuca*
5. *Xylaria berteri*
6. *Xylaria fioriana*
7. *Xylaria apiculata*
8. *Xylaria hypoxylon*
9. *Xylaria arbuscula*
10. *Xylaria castorea*
11. *Xylaria curta*
- 12, 15. *Podosordaria plumosa* 2 and 4 weeks old
13. *Xylaria appendiculata*
14. *Xylaria cubensis*



17. *Xylaria multiplex* (Kze, ex Fr.) Berkeley & Curtis

Berkeley M. J. Journ. Linn. Soc. **10**, 381, (1869). Currey F. Trans. Linn. Soc. Lond. **22**, 264, (1859). Dennis R. W. G. Kew Bull. **1956**, 417—418, (1956). Ellis J. B. & B. M. Everhart Journ. Mycol. **3**, 100, (1887); N. Amer. Pyren. 668, (1892). Hennings P. Bot. Jahrb. **17**, 7, (1893). Lévillé M. J. H. Ann. Sci. Nat. Bot. III, **3**, 42, (1845). Lloyd C. G. Myc. Writ. **5**: *Xylaria* Notes II, 25, (1918); Myc. Writ. **6**, 970, (1920). Miller J. H. Monog. Univ. Puerto Rico **B 2**, 217, (1934); Bothalia **4**, 266, (1942). Montagne J. F. C. in Gay: Hist. Chile VII, 431, (1850). Petch T. Ann. Roy. bot. gard. Perad **8**, 126, (1924). Theissen F. Denks. Akad. wiss. Wien math-naturw. klasse **83**, 68, (1927). Viégas A. P. Bragantia **4**, 112, (1944). sub *Sphaeria multiplex* Kze. x Fr. Fries E. M. Linnæa **5**, 536, (1830); Nova acta reg. Soc. Scient. Upsala III **1**, 111, (1851).

Stromata gregarious, linear, cylindric or spatulate with up to 2 clavata; clavata 0·8—3·0×1·0—4·5×2·1—39 mm with short grey to black sterile apices; stipes smooth or longitudinally channelled, 0·3—2·5×8—16 mm. Subiculum smooth, dense matted, dull brown or purple brown, ropy hyphae 3·0—4·5 $\mu$  in diameter; sometimes absent. Ectostroma persistent, crustose, in linear crusts, smooth, dull brown to black. Outer entostroma carbonaceous, inner fleshy, white, solid or with cavities. Perithecia vaguely evident to immersed, globose to oval, 350—700×500—700 $\mu$ ; ostioles medium papillate to invisible. Asci cylindric, 95—115×5—6 $\mu$ ; stipes 30—50 $\mu$ . Spores gibbous to navicular, narrow-ended, dark brown to black, sometimes with prominent sheaths, 3·5—5·0×8·5—12·5 $\mu$ , ave. 4·6×10·6 $\mu$ .

## Material examined:

Lyon in Sydow's Fungi Exotici exsiccati 990; on *Aleurites moluccana*, Oahu, Hawaii, (1913), sub *X. hypoxylon* forma *tropica*, (NYBG). Maguire 24681 F; Tafelberg, Surinam, (1944), (NYBG). Martin 643 ex Lowy; Baton Rouge, La., U.S.A., (1961). Martin 1550; San Blas, Nayarit, Mexico, (1961). Seaver and Chardon 177 in NYBG West Indies Explor. 512; Puerto Rico, (1923), (NYBG). sub *Xylaria constricta* ex Herb Massee; Dominica, (pre 1909), (NYBG). sub *Xylaria cylindrica* Smith; Castillo Ometepe, Nicaragua, (1893), (NYBG).

## Cultural characters (Plate IV:6; Plate VI:6):

Colonies velvet-felty, fine in texture, uniform, pure white or discoloured

PLATE VI. Surface characters of Colonies. All on malt agar, 2 weeks at 25°C unless otherwise stated

1. *Xylaria hypoxylon*: Young colony 4 days old showing white velvet habit characteristic of most *Xylaria* spp.
2. *Poronia punctata*
3. *Podosordaria hippotrichioides*
4. *Xylaria enteroleuca*
5. *Xylaria ianthino*—velutina
6. *Xylaria multiplex*
7. *Xylaria feejeensis*
8. *Xylaria digitata*
9. *Xylaria longipes*
10. *Xylaria curta*
11. *Xylaria polymorpha*

yellow. Margin distinct, entire; hyphae compact. Carbonization slight. Growth moderate, 3·7 mm/day at 25°C.

Coremia unbranched or forked, straight aristate, fan-shaped or spatulate, with setose bases, mostly dark superficially, smoky to glaucous except for white apices and yellow "collarettes", 0·5—2·5 × 15—50 mm. No conidia observed.

#### Microscopic characters:

Primary mycelium undiagnostic; maximum diameter of marginal hyphae = 1·5 $\mu$ . Secondary mycelium densely reticulate, uniform, 3·7—4·3 $\mu$  in diameter.

#### 18. *Xylaria feejeensis* Berkeley

Berkeley M. J. London Journal of Botany **1**, 456, (1842). Dennis R. W. G. Kew Bull. **1956**, 433, (1956). Lloyd C. G. Myc. Writ. **7**, 1253, (1924).

Stromata gregarious, unbranched; clavata cylindric, 1·2—1·7 × 1·8—2·0 × 4·5—15 mm, with fertile apices; stipes distinct, smooth, 0·8—1·5 × 12—17 mm. Subiculum smooth, dull brown; hyphae ropy, 1·8—2·5 $\mu$  in diameter. Ectostroma in elongate crustose plaques, dull murky brown; entostroma smooth, black and carbonaceous externally, internally pure white and fleshy, solid. Perithecia always several per stroma, with evident vertices or only vaguely evident, adjacent, oval, 300—350 × 350—400 $\mu$ ; ostioles prominent papillate. Asci cylindric, 95—120 × 4—5 $\mu$ ; stipes 45—54 $\mu$ . Spores oval to elliptic, gibbous, with narrow ends, dark brown to black, 4·5—5·0 × 8·5—9·5 $\mu$ , ave. 4·5 × 9·1 $\mu$ .

#### Material examined:

Martin 1776 ex Carroll 152; Dominical, Costa Rica, (1962).

#### Cultural characters (Plate VI:7):

Colonies velvet-felty, with fine texture, zonate with 1 or 2 zones, pure white. Margin distinct, segmented, hyphae compact. Carbonization slight to extensive. Growth moderate, 2·3 mm/day at 28°C optimum temperature.

Coremia unbranched, sessile, or stipitate and straight aristate, with dark basal mycelium only, white, fertile over apices and sides, 0·5—0·9 × 2·5—4·0 $\mu$ .

#### Microscopic characters:

Primary mycelium undiagnostic; maximum diameter of marginal hyphae = 2·2 $\mu$ . Secondary mycelium uniform, loose or closely reticulate, but sparingly branched, 1·5—3·7 $\mu$  in diameter.

#### Conidiophores and conidia (Plate VII:13):

Conidiophores irregular, produced off the ordinary colony surface or from the coremia, rather short, 51—70 × 1·2—1·8 $\mu$ ; branched to the first degree

proximally or distally, 2 or 3 fertile branches arising at a node. Fertile branches swollen, clavate or elliptic, lying freely or in trident formation,  $7.5-14 \times 2.5-4.3 \mu$ . Conidia acrogenous, on slender sterigmata, somewhat thick walled, clavate with narrow bases, cineraceous en masse,  $3.1-3.7 \times 6.2-7.5 \mu$ , ave.  $3.5-7.1 \mu$ .

19. *Xylaria gracillima* Fries

Fries E. M. *Linnaea* 5, 538, (1830). Hennings P. *Hedwigia* 43, 207, (1904). Lévillé M. J. H. *Ann. Sci. Nat. Bot.* III, 3, 42, (1845) sub *Sphaeria*.

Stromata separate or gregarious, unbranched; clavata narrow cylindric,  $0.8-1.5 \times 1.0-1.8 \times 8.0-13.5$  mm with fertile or sterile blunt apices; stipes distinct, smooth or longitudinally channelled,  $0.4-0.8 \times 10-21$  mm. Subiculum rough matted, dense to sparsely setose, dull brown; hyphae ropy,  $2.5-6.7 \mu$  in diameter. Ectostroma only feebly persistent, in linear crusts, fawn brown. Entostroma wrinkled or folded, black and carbonaceous externally, internally pure white and fleshy, solid. Perithecia always several per stroma, completely evident to vaguely evident, well apart to adjacent, globose,  $400-700 \times 400-700 \mu$ ; ostioles medium papillate. Asci not seen. Spores elliptic, gibbous, navicular or broad crescentic, with narrow distal ends and truncate proximal ends, each bearing a broad obtuse appendage, dark brown to black,  $5.0-5.5 \times 11.0-14.5 \mu$ , ave.  $5.2 \times 11.8 \mu$ .

Material examined:

Martin 926, 1514; San Blàs, Nayarit, Mexico, (1961, 1962).

Cultural characters:

Colonies velvety, with fine texture, uniform, pure white. Margin distinct, entire; hyphae compact. Carbonization extensive. Growth rate moderate,  $2.8$  mm/day at  $25^\circ\text{C}$ .

Coremia unbranched, straight aristate, with dark basal mycelium only, grey to white, fertile over the sides leaving the apices sterile,  $0.2-0.8 \times 13-41$  mm.

Microscopic characters:

Primary mycelium undiagnostic; maximum diameter of the marginal hyphae  $= 2.7 \mu$ . Secondary mycelium uniform, loose,  $3.7-4.5 \mu$  in diameter.

Conidiophores and conidia (Plate VII:3, 4):

Conidiophores in palisade formation, very short,  $18-25 \times 1.2 \mu$ , branched quadrately to the first or second degree near the apices. Fertile branches narrow, lying freely,  $4.3-13 \times 1.5-1.8$  mm. Conidia acrogenous, off slender sterigmata,

long pyriform with narrow distal ends, pale grey en masse,  $0.6-0.9 \times 3.7-4.3\mu$ , ave.  $0.8 \times 3.9\mu$ .

## 20. *Xylaria longipes* Nitschke

Bresadola G. & P. A. Saccardo *Malpighia* **11**, 293, (1897). Dennis R. W. G. *Kew Bull.* **1956**, 436, (1956). Fuckel L. *Symbolae Mycologicae* 238, (1869—1870). Hennings P. *Abh. Bot. Ver. Prov. Brand.* **40**, 160, (1898). Lloyd C. G. *Myc. Writ.* **6**, 995, (1920); *Ibid* **7**, 1247, (1924). Miller J. H. *Monog. Univ. Puerto Rico B* **2**, 217, (1934). Nitschke T. *Pyren. Germ* **1**, 14, (1867). Petch T. *Naturalist* **1939**, 157, (1939). Rabenhorst G. L. *Krypt. flor. Deutsch* **II**, 877, (1887). Rehm H. *Hedwigia* **21**, 135, (1882). Schröter T. in Cohn: *Kryptflor. Schlesien* 469, (1908). Traverso J. B. *Flora Ital Crypt.* **1**, 23, (1906).

Stromata gregarious, unbranched; clavata clavate to cylindric,  $1.6-8.0 \times 4.5-11 \times 10-46$  mm, with fertile apices; stipes distinct, longitudinally channelled or irregularly uneven,  $2.1-4.0 \times 9.0-41\mu$ . Subiculum smooth and even, dense matted, purple-brown; hyphae ropy,  $2.2-5.6\mu$  in diameter. Ectostroma in polygonal or linear crusts, fawn brown to black. Entostroma wrinkled, black and carbonaceous externally, internally fleshy, cream or white, solid. Perithecia always several per stroma, immersed, adjacent, oval,  $400-500 \times 600-700\mu$ ; ostioles medium papillate. Asci cylindric,  $110-175 \times 6-12\mu$ ; stipes  $45-90\mu$ . Spores navicular to broad crescentic, with narrow ends, spiral germ slits, and sometimes prominent sheaths, dark brown,  $5.0-6.5 \times 10.5-15.0\mu$ ; ave.  $5.7 \times 12.5\mu$ .

## Material examined:

Martin 676; culture only ex CBS, Baarn, Holland, (1961). Martin 904; ex Hennébert, Ottawa, Canada, (1961). Martin 1817 ex Carroll 162; Seeland, Denmark, (1962). Schnabl in Allescher & Schnabl's *Fungi Bavarici* 633; on *Acer pseudoplatanus*, Munich, Germany, (1898), (NYBG).

## Cultural characters (Plate VI:9):

Colonies felty to floccose, with fine texture, uniform, pure white. Margin distinct, lobed; hyphae compact. Carbonization absent. Growth rate moderate,  $3.0$  mm/day at  $25^{\circ}\text{C}$ .

Coremia unbranched to furcate, straight, aristate to clavate, mostly dark superficially, initially pink, fertile over the sides leaving the apices sterile  $0.8-2.5 \times 1.8-8.0$  mm.

## Microscopic characters:

Primary mycelium undiagnostic; maximum diameter of marginal hyphae  $=1.5\mu$ . Secondary mycelium uniform, loose,  $1.8-4.3\mu$  in diameter.

## Conidiophores and conidia (Plate VII:11):

Conidiophores produced irregularly, rather short,  $67-112 \times 1.2\mu$ , branched dichotomously to the first degree apically. Fertile branches lying freely, swollen



clavate,  $7.5-16 \times 2.7-4.3 \mu$ . Conidia acrogenous, sessile, somewhat thick-walled, clavate with narrow bases, cineraceous grey,  $2.5-3.7 \times 5.0-6.3 \mu$ , ave.  $3.1-5.8 \mu$ .

21. *Xylaria castorea* Berkeley (Plate II:14)

Cooke M. C. Handbook of Australian Fungi 286, (1892). Cooke M. C. & J. B. Ellis Grevillea 6, 92, (1878). Ellis J. B. & B. M. Everhart Journ. Mycol. 3, 112, (1887); N. Amer. Pyren. 666, (1892). Hawkins S. Proc. Indiana Acad. Sci. 35, 227, (1925). Lloyd C. G. Myc. Writ. 5: *Xylaria* Notes II, 17, (1918); Ibid 7, 1252, (1924). Miller J. H. Bothalia 4, 269, (1942). Van der Bijl P. Trans. Roy. Soc. S. Afr. 11, 207, (1924).

Stromata solitary, clavate, characteristically short, clavata  $5.0-14 \times 5.5-18 \times 15-55$  mm, unbranched with short sterile, often pannose, bases  $2.7-8 \times 4-35$  mm. Subiculum dense matted, pulvinate, purple brown; hyphae rosy, uniform,  $3.0-4.5 \mu$  diameter. Ectostroma rugose or smooth, forming small polygonal plaques but not conspicuously broken up, chestnut brown to black with age. Entostroma smooth or cast into small folds or wrinkles, carbonaceous externally, pure white internally. Perithecia always several per stroma, immersed, globose to oval,  $350-500 \times 500-600 \mu$ ; ostioles medium papillate. Asci cylindrical,  $70-130 \times 4.6 \mu$ ; stipes  $33-73 \mu$ . Spores oval, gibbous, broad-ended, dark brown, with prominent gelatinous sheaths,  $4.0-6.0 \times 7.0-10.5 \mu$ , ave.  $4.5 \times 9.1 \mu$ .

South African hosts: wood, unidentifiable

Material examined:

sub *Xylaria castorea*

Davidson 634; on *Fagus grandifolia*, Eden Lake, N. S., Canada, (FBLBC) Martin 56, 214, 456; Nature's Valley, Knysna District, Western Cape, South Africa, (1958, 1959). Massee; New Zealand, (details absent), (NYBG). Rick 82; Sao Leopoldo, Brazil, (1905), (NYBG). Rick 893; in Miller 8740 Porto Novo, Brazil, (date), (NYBG). White; Bar Harbour, Maine, U.S.A., (1901).

sub *Xylaria leprosa*

Rick; Sao Leopoldo, Rio Grande do Sul, Brazil, (1932), (NYBG).

Cultural characters (Plate IB:4; Plate V:10):

Colonies velvety, fine in texture, uniform, pure white. Margin distinct, entire or lobed, hyphae compact. Carbonization extensive. Growth moderate,  $1.2$  mm/day at  $25^{\circ}\text{C}$ .

Coremia unbranched, straight aristate, mostly dark superficially except for white apices,  $3-4 \times 50-70$  mm. No conidia observed.

Microscopic characters:

Primary mycelium undiagnostic; maximum diameter of the marginal hyphae  $= 2.0 \mu$ . Secondary mycelium uniform, reticulate,  $1.7-2.3 \mu$  in diameter.

10. *Xylaria leprosa* Spegazzini (Plate II:13; Fig. I:2).

Saccardo P. A. Sylloge Fungorum 9, 533, (1891). Spegazzini C. Bol. Acad. Nac. Cienc. Cordoba 11, 515, (1889); Anal. mus. nac. Buenos Aires 6, 262, (1899). Theissen F. Denk. Akad. wiss. Wien math-naturw. klasse 83, 63, (1927). Viégas A. P. Bragantia 4, 111, (1944).

Stromata aggregated; clavata unbranched, clavate to cylindric,  $1.5-9.0 \times 1.6-11 \times 16-85$  mm, with short sterile apices; stipes distinct, longitudinally channelled,  $0.6-5.0 \times 8.0-52$  mm. Subiculum rough, dense matted, dull brown; hyphae ropy,  $1.8-4.3\mu$  in diameter. Ectostroma tomentose to crustose, continuous, dull brown. Entostroma wrinkled, black and carbonaceous externally, internally white and fleshy, solid. Perithecia always several per stroma, immersed, adjacent, oval,  $300-400 \times 500-600\mu$ ; ostioles medium papillate. Asci cylindric,  $145-180 \times 6-10\mu$ ; stipes  $67-83\mu$ . Spores elliptic, navicular, with broad ends, prominent gelatinous sheaths and spiral germ slits, dark brown,  $5.0-7.5 \times 13.5-22.5\mu$ , ave.  $5.8 \times 17.3\mu$ .

South African hosts: *Olea capensis*

## Material examined:

Martin 65, 66, 133, 455, 497, 507; Nature's Valley, Knysna District, Western Cape, South Africa (1958, 1959).

## Cultural characters (Plate IV:5):

Colonies velvety, with fine texture, uniform, pure white. Margin distinct, lobed; hyphae compact. Carbonization extensive. Growth rate moderate, 2.5 mm/day at 25°C.

Coremia unbranched, straight aristate, spirally twisted or crooked, mostly dark superficially but with white apices, densely shaggy,  $3.0-4.0 \times 50-70$  mm, with conidia sometimes produced over the apices.

## Microscopic characters:

Primary mycelium undiagnostic; maximum diameter of the marginal hyphae  $= 2.1\mu$ . Secondary mycelium reticulate, uniform, close anastomosed,  $1.3-2.5\mu$  in diameter.

## Conidiophores and conidia:

Conidiophores produced in palisade formation, short,  $50-100 \times 2.5-3.1\mu$ ; branched dichotomously to the second degree, throughout or distally. Fertile branches lying freely, narrow,  $40-60 \times 2.0-3.0\mu$ . Conidia acrogenous, off slender sterigmata, oval, pale grey en masse,  $3.0-4.5 \times 4.5-8.3\mu$ , ave.  $3.5-6.6\mu$ .

In the species described above, coremia have been observed by the writer and by other authors. Material corresponding to *X. grammica* however yielded a fine velvet colony without carbonization and without coremia, showing that all species of *Xylaria* do not necessarily give rise to the characteristic colony pattern.

### **Poronia & Podosordaria**

In the remaining two genera the stroma differs significantly in the nature of the outermost layers. In the true species of *Xylaria* and *Kretzschmaria* the ectostroma is the outer layer and the carbonaceous layer of the entostroma lies beneath. In *Podosordaria* Ellis & Holway (1897) and in *Poronia* Willdenow (1787) there is no carbonaceous material, and in *Podosordaria* no ectostroma either so that the entostroma becomes the surface of the stroma.

In *Poronia punctata* the cupulate or discoid form of the clavata, the vertical perithecia, and the distinct white ectostroma are probably sufficient for generic distinction. (See Plate III:5). In *P. oedipus* since the stroma is concolorous it is hard to say whether the surface layer is the ectostroma or not. Since the surface around the ostioles is cracked irregularly, however, and the smooth ostioles of other species are united with the ectostroma, the writer takes the view that there is a rudimentary ectostroma present. It is not possible for the writer at present to delimit the other species of *Poronia* because insufficient material has been examined.

**Poronia** Willdenow, C. L. Florae Berolinensis Prodomus. Berolini, Impensis Wilhelmi Yiewegii, (1787).

The genus was originally based on *P. gleditschii* Willdenow, and *Poronia* was subsequently adopted by Fries, who changed the specific name to *P. punctata*. Subsequently Cooke (1884), Corda (1837—1842), Dawson (1900), Hansen (1876) and Lloyd (1920) have expanded and further defined the generic concept. Other species of *Poronia* include *P. agariciformis*, Lloyd, *P. arenaria* Syd. & Butler, *P. caelata* Pat., *P. chardoniana* Toro, *P. cupularis* Lloyd, *P. ehrenbergii* Henn., *P. formicata* Moll., *P. gigantea* Sacc., *P. heliscus* Mont., *P. hemisphaerica* Starbäck, *P. hypoxyloides* Rehm., *P. indica* Ahmad, *P. minuta* Petch, *P. oedipus* Mont., *P. pileiformis* (Berk.) Fr., *P. pocula* Lloyd, *P. polyporoides* Henni., *P. scutellata* Fr., and *P. turbinata* E. & E. The taxonomic position of these, with the exception of *P. oedipus* is uncertain. *Poronia doumetii* Pat., *P. kurziana* (Curr.) Lloyd, *P. leporina* E. & E., *P. macrorhiza* Speg. and *P. ustorum* Pat. are transferred by the writer here to *Podosordaria*.

### **Key**

- 1 Ectostroma white, continuous or cracked; clavata variable in form from urceolate to oval applanate with convex to concave surface; spores equilateral, broad-ended, black with wide hyaline gelatinous sheaths,  $13.5-14.5 \times 22.0-23.5 \mu$   
*Poronia punctata* Fr.

- 1' Ectostroma brown, continuous and hard to distinguish from entostroma beneath; clavata discoid or urceolate with flat or concave surface; spores equilateral, narrow-ended, dark brown, with prominent gelatinous sheaths,  $13.5\text{--}15.0 \times 23.5\text{--}25.5 \mu$

*Poronia oedipus* Mont. (Plate III: 6)

1. *Poronia punctata* Fries (Plate III: 3, 5, 7)

Ahmad S. Lloydia **9**, 140, (1946). Berkeley M. J. in Smith J. E.: English Flora **5** (2), 235, (1836); Outlines of British Fungology 385 (1860). Brefeld O. Untersuchungen aus dem Gesamtgebiete der Mykologie X, Ascomyceten **2**, 261, (1891). Cooke M. C. Handbook of British Fungi **II**, 791, (1871); Grevillea **8**, 72, (1879); Handbook of Australian Fungi 289, (1892). Currey F. Jour. Linn. Soc. Lond. **22**, 265, (1859). Dawson M. Ann. Bot. **14**, 245—260, (1900). Dennis R. W. G. British Cup Fungi 182, (1960). Ellis, J. B. & B. M. Everhart, Jour. Mycol. **3**, 112, (1887); N. Amer. Pyren. 659, (1892). Fabrè J. H. Ann. Sci. Nat. VI, **9**, 81, (1879). Ferdinandsen C. & D. Winge. Mykologisk Ekskursionsflora 399, (1943). Fries E. M. Systema Mycologicum 330, (1823); Summa Veg. Scand. 382, (1849). Greville R. K. Scottish Crypt. Flora **6**, 327, (1828). Gwynne-Vaughan H. C. I. & B. F. Barnes. Structure and Development of the Fungi 269, (1937). Hansen E. C. Vidensk Meddel. fra den Naturh. Foren. **16**, 301, (1876). Hooker W. J. Flora Scotica **II**, 5, (1821). Jaczewski A. L. Bull. Soc. Myc. de Fr. **11**, 129, (1895). Karsten P. A. Mycologica fennica II. Pyrenomycetes 36, (1873). Kickx J. Flora crypt. de Flandres 309, (1867). Lambotte E. Flore mycol. belge 432, (1880). Lindau G. in Engler & Prantl: Die Natürlichen Pflanzenfamilien X, 489, (1897); Die Mikroskopischen Pilze in Krypt. für Anfänger **3** (1), 137, (1897). Lloyd C. G. Myc. Writ. **5**: Letter 66, 2—3, (1917); Myc. Writ. **6**, 937, (1920). Miller J. H. Mycologia **20**, 204, (1928); Bothalia **4**, 262, (1942). Nitschke T. Pyren. Germ. **1**, 19, (1867). Quélet L. Champ Jura & Vosges 489, (1875). Rabenhorst G. L. Deutsch. Kryptflor. **I**, 223, (1844). Rabenhorst L. Kryptflor Deutsch. **II**, 870, (1887). Rehm H. Berichte Naturh. Ver. Augsburg. **26**, 44, (1881); Ascomycetes Lojani Hungaria 33, (1882). Schröter J. in Cohn: Kryptflora Schlesien 466, (1908). Starbäck K. Bih. Svenska Vet-akad. Handl. **15**, 8, (1889). Traverso J. B. Flora Ital. Crypt **1**, 31, (1906).

sub *Poronia gleditschii* Willdenow

Greville R. K. Scottish Crypt Flora **6**, 327, (1828). Willdenow C. L. Florae berolinensis Prodrum 400, (1787).

sub *Peziza punctata* Linnaeus, C. Flora Suecica **II**, 458, (1755).

sub *Sphaeria poronia* Persoon.

Persoon C. H. Comment. Fung. Clav. 151, (1797); Syn. Meth. Fung. **15**, (1801—1808).

Stromata gregarious, on dead stems or dung of various animals, unbranched or with up to 3 branches; clavate urceolate or applanate,  $0.7\text{--}5.0 \times 0.9\text{--}7.0 \times 0.5\text{--}2.5$  mm; stipes absent so that stroma is anchored at a central point only, ill-differentiated, or distinct, dull brown, smooth,  $0.4\text{--}1.5 \times 0.0\text{--}9.0$  mm. Subiculum absent. Ectostroma convex, flat or concave, crustose, continuous except for protruding ostioles, pure white, corky. Entostroma corky to fleshy, without an external carbonaceous layer, and the outer part is usually ochraceous in colour, and the basal tissue pure white, solid. Perithecia always several per stroma, completely immersed, vertically oriented, adjacent, oval,  $300\text{--}900 \times 400\text{--}900 \mu$ ; ostioles medium to prominent papillate. Asci cylindric or obclavate with narrow distal ends, with spores in monostichous or distichous formation,  $140\text{--}190 \times 19\text{--}34 \mu$ ; stipes  $10\text{--}30 \mu$ . Spores oval to elliptic, equilateral, with broad ends, and prominent gelatinous sheaths,  $12.0\text{--}16.5 \times 19.5\text{--}25.5 \mu$ , ave.  $12.8 \times 22.6 \mu$ .

## Material examined:

Martin 1757 ex Carroll 97; San Cristobal, Chiapas, Mexico, (1962). Martin 1796 ex Carroll 179; Jylland, Denmark, (1962). Miller; Bethel, Canyon City, Colo., U.S.A., (1913). (Mill.)

## Imperfect stage:

Brefeld (1891), loc. cit. Cornu Ann. Sci. Nat. Bot. **6**, 85—86, (1876). Dawson (1900), Lindau (1897), Traverso (1906), loc. cit.

## Cultural characters (Plate VI:2):

Colonies velvety, with fine texture, uniform, pure white. Margin distinct, segmented; hyphae compact. Carbonization absent. Growth rate slow, 2·1 mm/day at 28°C optimum temperature.

Coremia unbranched, curved, aristate, white, without dark hyphae, sterile or fertile apically, 0·6—0·9 × 4·5—11 mm.

## Microscopic characters:

Primary mycelium undiagnostic; maximum diameter of the marginal hyphae = 2·0 μ. Secondary mycelium absent.

## Conidiophores and conidia (Plate VII:2):

Conidiophores formed irregularly, rather short, 27—35 × 1·8 μ, unbranched or branched dichotomously once distally. Fertile branches narrow, lying freely, smooth, 9·6—16 × 1·2—1·8 μ. Conidia randomly developed or pleuracrogenous, on slender sterigmata, pyriform, white, 1·2—1·8 × 3·7—5·6 μ, ave. 1·5 × 4·8 μ.

***Podosordaria* Ellis & Holway E.W.D. Bot. Gaz. 24, 37, (1897).**

Dennis R. W. G. Kew Bull. **1956**, 442—443, (1956); Ibid **1957**, 305—306, (1957). Seaver F. J. et al Mycologia **19**, 43—50, (1927).

*Podosordaria*, like *Penzigia*, has never been critically defined, and the determinant characters are not easy to make out from the description. The “carnose texture and light brown colour” found in many species originally placed in *Kretzschmaria* and *Xylaria* refer, in the writer’s opinion, to the outer superficial uncarbonized entostromal layer visible in actual specimens of the type, *P. mexicana*. Since this structure is not typical for *Xylaria* or *Kretzschmaria*, inclusion of these species in *Podosordaria* is appropriate. It is probable that the limits of the genus are wider than previously supposed, and many species of *Xylaria* with ill-defined ectostroma are obviously close to *Podosordaria*, both in structure and host substrate preference. Dennis (1957, p. 306) transfers 3 species, *P. pedunculata* (Gray) Dennis, *P. tulasnei* (Nits.) Dennis, and *P. leporina* (E. & E.) Dennis from *Xylaria* and describes several further species of *Xylaria* which the present writer feels on the basis of his own examination belong in *Podosordaria*.

as well. Some of these, *X. nigripes* (Klotzsch) Cooke, *Xylaria axifera* Mont., *X. aristata* Mont., and allied species, have an entostroma that is superficially carbonous at maturity, and is thus intermediate between *P. mexicana* and *Xylaria* sensu strictu. The writer feels that the lack of ectostroma should take precedence, so that these species would still be grouped in *Podosordaria*. This is, however, an arbitrary decision, since the problem of overlapping characters is never easy to resolve (See Plate III:9, 11).

*Podosordaria* is certainly homologous with the later genus *Carnostroma* proposed by Lloyd (1919, p. 27). The single species *C. thyrsus* (Berk.) Lloyd has a dull outer surface but it lacks rigidity, and there is no suggestion of an ectostroma. The substrate is soil.

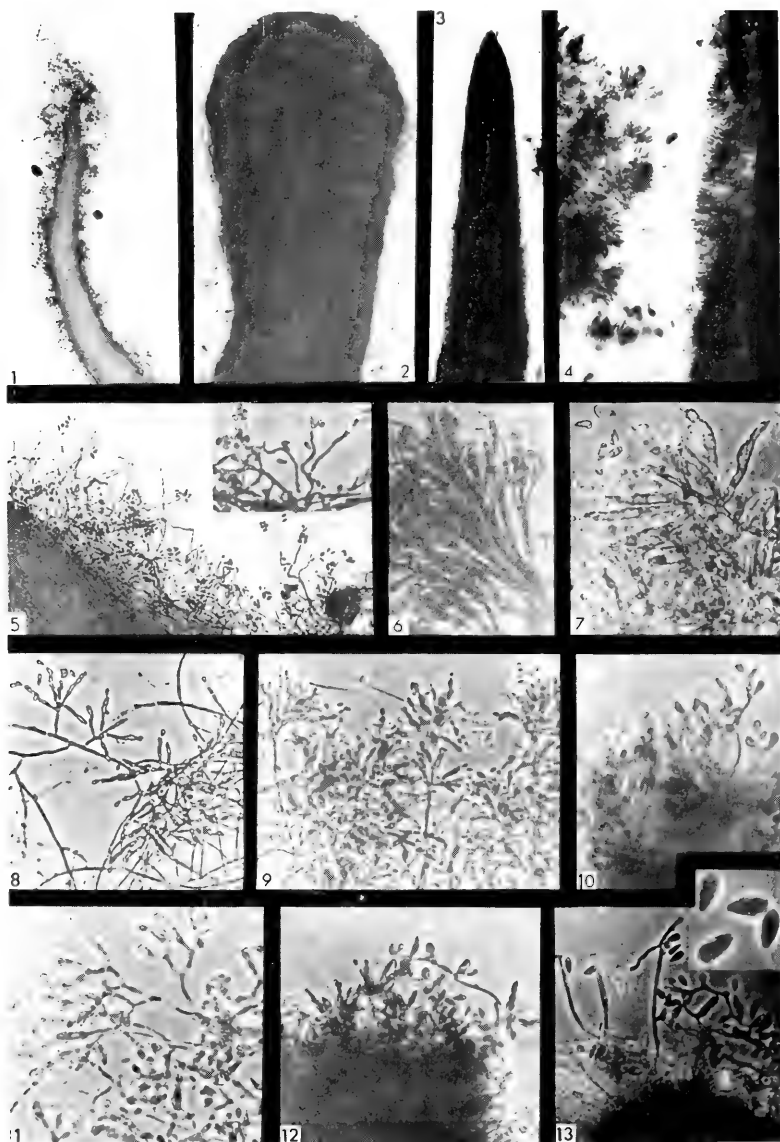
*Podosordaria* is probably also synonymous with *Xylariodiscus* Hennings (1899), but the writer has not had the opportunity to examine the type species *X. dorstenioides* Henn. Theissen (1908) has criticised the establishment of *Xylariodiscus* on the sole character of the aplano-pulvinate clava: "... so müssen wir für *Xylaria aristata* mit kugelig em kopfchen ebenfalls eine *Xylariosphaera* einführen, für *Xylaria thyrsus* mit Kegelformigen keule eine *Xylariocone*, usw. ..."

About the imperfect characters of *Podosordaria* little is known. Dixon (1965) has described a conidial form for *P. furcata* (sub *Xylosphaera furcata* (Fr) Dennis) unusual in the method of spore discharge, but in other respects consistent with species of *Xylaria*.

#### Key to the Species

- |       |   |    |
|-------|---|----|
| 1     | Outer layer of the stroma white, yellow brown, ochraceous or grey and uncarbonized or with minimal carbonization.....   | 2  |
| 1'    | Outer layer of stroma black, hard or carbonaceous.....  | 12 |
| 2     | Stroma with sterile apex.....   | 9  |
| 2'    | Stroma fertile to the apices.....   | 2  |
| 3     | Stromata long stipitate, stipes over 15 mm long.....  | 8  |
| 3'    | Stromata short stipitate, stipes less than 15 mm long.....  | 4  |
| 4     | On dead grass stems.....  | 5  |
| 4'    | On other substrate.....   | 6  |
| 5     | Stromata small, unbranched, 1.7—2.8 mm diam., 0.8—1.0 mm high; surface cream coloured; spores gibbous, narrow ended, medium brown, 5.5×9.5μ   |    |
|       | <i>Podosordaria ustorum</i> (Pat) Martin  |    |
|       | syn. <i>Poronia ustorum</i> Patouillard   |    |
|       | <i>Xylaria ustorum</i> (Pat.) Dennis  |    |
| 5'    | Stromata usually branched at the base of the stipe; clavulae pulvinate to hemispheric, 1.5—2.1×2.5—3×1.4—1.7 mm; spores 5—9×14—18μ  |    |
|       | <i>Podosordaria kurziana</i> (Currey) Martin  |    |
|       | syn. <i>Xylaria kurziana</i> Currey   |    |
| 6 (4) | On wood: stromata branched at base of stipe; clavulae pulvinate, narrower than long, 3—4.5×5—6×2—3 mm; surface yellow ochre; spores equilateral, acute ended, dark brown, 5.5×15.0μ |    |
|       | <i>Podosordaria truncata</i> (Pat.) Martin  |    |
|       | syn. <i>Kretzschmaria truncata</i> Patouillard  |    |
| 6'    | On wood: stromata unbranched, dark brown, small, with setose hyphae   |    |
|       | <i>Podosordaria ciliata</i> (Pat.) Martin   |    |
|       | syn. <i>Xylaria ciliata</i> Patouillard   |    |

- 6' On dung; stromata unbranched, clavata pulvinate, spores with prominent sheaths 7  
7 Spores gibbous, narrow-ended, dark brown,  $7.5 \times 15.0 \mu$ ; on rabbit dung  
    *Podosordaria leporina* (E & E) Dennis (Plate III:8, 9)  
    syn. *Poronia leporina* Ellis & Everhart  
7' Spores equilateral, broad-ended, black,  $15.5-16.0 \times 28.5-30.5 \mu$ ; on cow dung  
    *Podosordaria mexicana* Ellis & Holway  
    syn. *Xylaria chardoniana* (Toro.) Miller  
    *Penzigia chardoniana* Toro.  
8 (3) Surface of clava light brown, stipes 15—17 mm, perithecia evident; spores gibbous  
    with acute ends, pale to medium brown,  $5.0 \times 13.0 \mu$ . Substrate: dead herbaceous  
    stems  
    *Podosordaria rhizophila* (Cke. & Mass.) Martin  
    syn. *Xylaria rhizophila* Cooke & Massee  
8' Surface of clava yellow ochre, stipes up to 85 mm; perithecia evident; spores  
    gibbous, narrow-ended, dark brown,  $4.0 \times 8.0 \mu$ . Substrate: dead leaves  
    *Podosordaria pyramidata* (Berk.) Martin  
    syn. *Xylaria pyramidata* Berkeley  
    ? *Xylariodiscus dorstenioides* Hennings  
8'' Surface of clava cream-coloured; clavata aplanate, somewhat resupinate on axes,  
    stipes up to 60 mm; perithecia evident; spores elliptic, broad-ended, dark brown,  
     $13-14 \times 28 \mu$ . Substrate: dung  
    *Podosordaria macrorhiza* (Speg.) Martin (Plate III:4)  
    syn. *Poronia macrorhiza* Spegazzini  
8''' Surface of clava white, clavata flat pulvinate, stipes up to 100 mm, setose; peri-  
    thecia not evident; spores elliptic, narrow-ended, medium brown,  $9.0 \times 15.5 \mu$   
    *Podosordaria doumetii* (Pat.) Martin  
    syn. *Poronia doumetii* Patouillard  
9 (2) Stromata small, filiform; clavata pulvinate, with perithecia scattered over stipe,  
    single or grouped, evident in outline; spores gibbous, narrow-ended, black,  
     $8.0 \times 15.0 \mu$ , with prominent gelatinous sheaths; on dung  
    *Podosordaria hippotrichioides* (Sow.) Martin  
    syn. *Xylaria hippotrichioides* Sowerby  
9' Stromata robust, growing from earth.....10  
10 Clavata short pulvinate with conical apices, spores with prominent sheaths....11  
10' Clavata short cylindric with apex produced; surface grey, perithecia vaguely  
    evident; spores  $12.0 \times 40.0 \mu$   
    *Podosordaria thyrsus* (Berk.) Martin  
    syn. *Carnostroma thyrsus* (Berk.) Lloyd  
    *Xylaria thyrsus* Berkeley  
11 Spores equilateral, broad-ended, dark brown,  $10.5 \times 20.0 \mu$   
    *Podosordaria tulasnei* (Nits.) Dennis  
    syn. *Xylaria tulasnei* Nitschke  
11' Spores equilateral, narrow-ended, black,  $20.5 \times 39.0 \mu$   
    *Podosordaria pedunculata* (Dicks.) Dennis  
    syn. *Xylaria pedunculata* Gray  
12 (1) Subiculum present as a rough tomentose covering beneath the stromata; apex  
    sometimes produced with 1 or 2 depressed ostioles but not definitely sterile;  
    stromata pulvinate, 1—2 peritheciate, occurring on wood; spores gibbous to  
    navicular, with acute ends, medium brown,  $7.0 \times 15.5 \mu$   
    *Podosordaria copelandii* (Henn.) Martin  
    syn. *Xylaria copelandii* Hennings  
12' Subiculum present only as a fine setose covering on the stipes or absent; apices of  
    stromata sterile.....15  
12'' Subiculum absent; apices fertile or with definite perithecial rudiments.....13  
13 Stromata small, with pulvinate clavata 1—2 mm in diameter and 1 mm high, on  
    very short stipes; surface of stromata granulate but without definite ecostroma;  
    spores equilateral, broad-ended, black, with prominent sheaths,  $6.5 \times 12.0 \mu$ . On  
    wood  
    *Podosordaria plumosa* Martin nov. sp.  
13' Stromata elongate cylindric, robust, inhabiting termite nests; spore sheath not  
    evident





- 14 Stromata simple, clavate or cylindric; spores gibbous, broad-ended, dark brown,  $3.0 \times 4.0 \mu$   
*Podosordaria nigripes* (Klotz.) Martin  
 syn. *Xylaria nigripes* (Klotz.) Saccardo
- 14' Stromata branched to the first or second degree, narrow cylindric; spores gibbous, narrow-ended, dark brown,  $2.5 \times 4.5 \mu$   
*Podosordaria furcata* (Fr.) Martin  
 syn. *Xylaria furcata* Fries
- 15 (12) Stipes long and twisted supporting clavate or pulvinate heads; clavata often characteristically bifurcate. Spores gibbous, narrow-ended, medium brown, with straight or sinuous germ slits  $6.0 \times 11.0 \mu$ . Habitat: soil  
*Podosordaria vaporaria* (Berk. & Curr.) Martin  
 syn. *Xylaria vaporaria* (Berkeley & Currey) ..... 16
- 15' Stipes relatively short, substrate wood or leaves ..... 16
- 16 Surface of stroma with gummous or resinous crusts, though no definite ectostroma; clava globose conic; spores gibbous, narrow-ended, dark brown,  $8.0 \times 22.5 \mu$ ; on wood or dead leaves  
*Podosordaria axifera* (Mont.) Martin  
 syn. *Xylaria axifera* Montagne
- 16' Surface of stroma smooth with dry appearance; apparently restricted to dead leaves ..... 16
- 17 Spores appendiculate, gibbous to navicular, narrow-ended, dark brown,  $7.0-8.0 \times 12.0-13.5 \mu$   
*Podosordaria appendiculata* (Ferd. & Wge.) Martin  
 syn. *Xylaria appendiculata* Ferdinandsen & Winge ..... 18
- 17' Spores without appendage ..... 18
- 18 Stipes setose or loosely subiculate ..... 19
- 18' Stipes glabrous ..... 20
- 19 Spores gibbous to navicular, with acute ends, medium brown,  $4.0-6.5 \times 10.0-11.0 \mu$   
*Podosordaria filiformis* (A. & S.) Martin  
 syn. *Xylaria filiformis* (A. & S.) Fries
- 19' Spores gibbous, with broad or narrow ends, dark brown,  $6.0 \times 17.5 \mu$   
*Podosordaria heloidea* (Penz. & Sacc.) Martin  
 syn. *Xylaria heloidea* Penzig & Saccardo
- 20 (18) Spores  $4 \times 6 \mu$   
*Podosordaria sicula* (Pass. & Belt.) Martin  
 syn. *Xylaria setocephala* Yeates  
*Xylaria sicula* Passerini & Beltrano

## PLATE VII. Conidiophores and Conidia

- 1—4. Coremia
1. *Podosordaria hippotrichioides*  $\times (40)$
  2. *Poronia punctata*  $\times (40)$
  3. *Xylaria gracillima*  $\times (40)$
  4. *Xylaria gracillima*  $\times (160)$   
 : right, conidiophores in palisade formation on coremium; left, conidiophores teased out from coremium.
  5. *Podosordaria hippotrichioides*: Coremial surface with *Nodulisporium* conidiophores  $\times (160)$  Inset: Detail of conidiophores  $\times (210)$
  6. *Kretzschmaria heliscus*  $\times (210)$
  7. *Xylaria anisopleura*  $\times (210)$
  8. *Xylaria enteroleuca*  $\times (210)$
  9. *Xylaria fioriana*  $\times (210)$
  10. *Xylaria cornudamae*  $\times (210)$
  11. *Xylaria longipes*  $\times (210)$
  12. *Xylaria curta*  $\times (210)$
  13. *Xylaria feejeensis*  $\times (210)$  Inset: Detail of spores  $\times (540)$

- 20' Spores navicular to crescentic, with narrow ends, dark brown,  $6.5 \times 11.0 \mu$   
*Podosordaria aristata* (Mont.) Martin  
 syn. *Xylaria aristata* Montagne
- 20'' Spores navicular, with narrow ends, medium brown,  $8 \times 20-28 \mu$   
*Podosordaria schreuderiana* (van der Byl) Martin  
 syn. *Xylaria schreuderiana* van der Byl

#### Analysis of species:

##### 1. *Podosordaria nigripes* (Klotzsch) Martin

sub *Xylaria nigripes* (Klotzsch) Cooke

Cooke M. C. *Grevillea* **11**, 84-85, (1883). Lloyd C. G. *Myc. Writ.* **6**, 893, (1919); *Ibid* **6**, 973, (1920); *Ibid* **6**, 1087, (1921); *Ibid* **7**, 1251, (1924). Miller J. H. *Bothalia* **4**, 269, (1942). Petch T. *Ann. Roy. Bot. Gard. Perad.* **3**, 237-243, 246-248, (1906); *Ann. Mycol.* **5**, 401-403, (1907); *Ann. Roy. Bot. Gard. Perad* **5**, 328-333, (1913); *Ibid* **5**, 306-307, (1913). Raut A. *Tidsch. Teysmannia Affl.* **4** & **5**, 171-173, (1921). Rehm H. *Hedwigia* **28**, 299, (1889). Saccardo P. A. *Syll. Fung. IX*, 527, (1891). Sydow H. & P., & E. J. *Butler Ann. Mycol.* **9**, 419, (1911).

sub *Xylaria flagelliformis* Curr. & *X. mutabilis* Curr. Currey F. *Trans. Linn. Soc. Lond. II*, **1**, 129, (1876).

sub *Xylaria gardneri* Berkeley

Berkeley M. J. & C. E. Broome J. *Linn. Soc. Lond.* **14**, 118, (1875).

Stromata gregarious, unbranched; clavata cylindric,  $3.0-3.5 \times 2.0-4.0 \times 10-35$  mm, with fertile apices; stipes distinct, smooth,  $1.5-2.0 \times 90-100$  mm. Subiculum absent. Ectostroma absent at maturity. Entostroma sandy brown to black, verruculose, crinkled, externally carbonaceous, internally fleshy, solid, dull yellow to dull brown or black. Perithecia several per stroma, vaguely evident, adjacent, oval,  $250-300 \times 750-800 \mu$ ; ostioles medium papillate to prominent. Asci quoted by Miller as cylindric,  $40-46 \times 4-5 \mu$ ; stipes  $14 \mu$ . Spores broad oval, gibbous, dark brown,  $2.5-3.0 \times 3.5-4.5 \mu$ , ave.  $3.1 \times 4.1 \mu$ .

#### Material examined:

Van Hohnel in Rehm's *Ascomyceten* 1810; on termite nests, Buitenzorg, Java, (1907-1908), (NYBG). Martin 1613 (culture only) ex Wright 2081; Misiones, Argentina, (1962).

#### Imperfect stage:

sub *Sclerotium stipitatum*

Berkeley M. J. *Trans Linn. Soc. Lond.* **23**, 91-92, (1862). Petch T. *Ann. Roy. Bot. Gard Perad.* **5**, 306-307, (1913).

sub *Xylaria nigripes*

Petch T. (1907), (1913), loc. cit.

Colonies velvet-felty, with coarse texture, uniform, pure white. Margin not distinct, entire; hyphae compact. Carbonization slight. Growth slow, 1.9 mm/day at 25°C. No conidia were observed. Petch describes a coremial structure typical for *Xylaria*, with narrow conidia,  $2 \times 4-6 \mu$ .

##### 2. *Podosordaria plumosa* Martin nov. sp. (Plate III:10, Fig. 1:6).

Stromata minoris, nigra; clavata 3-4 mm lata, stipes 0.3-2 mm longis; sporae nigrae, medius  $6.4 \times 12.2 \mu$ . In ligno.

Stromata small, superficial on decorticated wood, clearly divided into a flat or convex fertile portion 3.0—4.0 mm in horizontal diameter and a narrow terete glabrous stipe 0.5—0.8 × 0.3—2.0 mm long. Ectostroma not visibly retained at maturity, crustose, continuous, dull brown. Entostroma with the usual differentiation into a hard carbonous exterior and fleshy white basal tissue, the latter persistent in contrast to the previous two species. Perithecia 4—10 per stroma, vaguely evident in outline, globose, 500—650 × 600—700 $\mu$ ; ostioles indistinct papillate. Asci clavate or cylindric, long stipitate, 115—160 × 10—12 $\mu$ ; stipes 50—85 $\mu$ . Spores oval, equilateral with rounded ends, with prominent gelatinous sheaths, black, 5.0—7.5 × 10.5—13.5 $\mu$ , ave. 6.4 × 12.2 $\mu$ .

South African hosts: *Lycium campanulatum*, old and very decayed wood.

Material examined:

Martin 410; Fish River Valley, nr Grahamstown, E. Cape, South Africa, (1958).

Cultural characters (Plate IV:9; Plate V:12,15):

Colonies velvety, dense and closely appressed, zonate with 3 or more zones produced by 14 days, with a rather coarse surface, dull white opaque, tinted pink. Margin distinct, 1—2 mm wide, canescent at first becoming plumose, entire or irregularly segmented, compact. No stain or carbonization. Growth rate slow, 1.9 mm/day at 28°C optimum temperature. Growth on Leonian's broadly similar, on maize and Czapek considerably reduced, submersed, uniform, white subhyaline and gelatinous. When grown on wood blocks the fungus develops long plumose tassels of parallel hyphae up to 15 mm long and 2 mm wide. No coremia have been observed.

Microscopic characters (Fig. II:11):

Primary mycelium undiagnostic; maximum diameter of the marginal hyphae = 2.6 $\mu$ . Secondary mycelium loose, 1.8—5.4 $\mu$  in diameter.

Conidiophores and conidia:

Sterile, both in the field and in culture.

3. *Podosordaria hippotrichioides* (Sow.) Martin nov. comb. (Plate III: 11)

sub *Xylaria hippotrichioides* Sowerby

Berkeley, M. J. Mag. Zool. & Bot. 3, 205, (1838). Jaczewski A. L. Bull. Soc. Myc. de France 11, 131, (1895). Petch T. Naturalist 1939, 159, (1939).

Stromata gregarious, growing on dung, unbranched, consisting of a relatively long sinuous stipe, dull brown and smooth, 0.2—0.3 × 5.0—7.0 mm, bearing perithecia in an ill-differentiated distal cylindric clava, 0.6—0.7 × 0.6—0.9 × 0.7—1.5 mm. Subiculum absent. Ectostroma not clearly distinct; entostroma externally smooth, convex, dull brown and corky, internally fleshy, dull white.

Perithecia 1—7 per stroma, evident to base, laterally oriented, oval,  $300—400 \times 400 \times 400—500\mu$ ; ostioles medium papillate. Asci cylindric,  $95—105 \times 8—9\mu$ ; stipes  $16—24\mu$ . Ascus plugs not apparently present. Spores oval, gibbous, with narrow ends and prominent gelatinous sheaths, black,  $7.0—9.0 \times 13.0—16.5\mu$ , ave.  $8.0 \times 15.0\mu$ .

**Material examined:**

Martin 1812 ex Cain, Mt. Toby, Mass., U.S.A., (1963).

**Cultural characters (Plate VI:3):**

Colonies felty, with coarse texture, strongly zonate, pure white. Margin not distinct; hyphae compact. Carbonization absent. Growth rate slow, 0.9 mm/day at 15°C temperature optimum.

Coremia unbranched, curved, aristate, without dark mycelium, white, fertile over apices and sides,  $0.2—0.3 \times 2.0—7.0$  mm.

**Microscopic characters:**

Primary mycelium undiagnostic; maximum diameter of the marginal hyphae  $=1.8\mu$ . Secondary mycelium absent.

**Conidiophores and conidia (Plate VII:1, 5):**

Conidiophores produced directly off the colonies as well as off the coremia, developed irregularly,  $220—375 \times 1.5\mu$ , branched dichotomously or ternately to the first degree distally or over the entire length of the axes. Fertile branches lying freely, narrow, regular, partly serrate or typically geniculate (*Nodulisporium*),  $15—45 \times 1.8—2.4\mu$ . Conidia acrogenous or pleuracrogenous, off stout sterigmata, somewhat thick-walled, narrow clavate, white en masse,  $1.8—3.1 \times 4.3—7.5\mu$ , ave.  $2.5 \times 5.3\mu$ .

**4. *Podosordaria sicula* (Pass. & Belt.) Martin nov. comb.**

sub *Xylaria sicula* Passerini & Beltrani

Lloyd C. G. Myc. Writ. 7, 1253, 1309, (1924); Passerini G. & Beltrani I. Hedwigia 22, 120, (1883). Saccardo P. Sylloge Fungorum IX, 534, (1891). Traverso J. B. Flora Ital. Crypt. 1, 26, (1906).

Stromata gregarious, on leaves, very minute, unbranched; clavata globose, weakly differentiated,  $800—1000\mu$  in diameter with up to 4 perithecia in evident outline; stipes  $300 \times 3000\mu$ , smooth, often continued above the stroma for another 6 mm to end in a long black apex. Subiculum absent but stipe is often sparsely setose. Ectostroma absent. Entostroma convex, verrucose, dull black, externally somewhat carbonaceous but not rigid, internally fleshy and pure white, solid. Perithecia oval, adjacent,  $300—400 \times 500—600\mu$ ; ostioles medium papillate. Asci and spores not seen since material examined was immature. Spores quoted as  $4 \times 6\mu$  in literature.

Stroma with supplied ectostroma	Perithecia vertically oriented only; sterile apices of stro- mata excentric when present	Ectostroma continuous	Species partly intermediate with <i>Hypoxylon</i> with sessile or subsessile aplanate forms Species always distinctly spitulate, without hypoxylloid forms	Dark mycelium scanty or absent from coremia, or developed in culture; coremia often clavate or spatulate	Conidiophores irregularly arranged or in palsade formation	ectostroma tomentose	K. deusta
Stroma with black or carbonaceous ectostromal layer	Perithecia vertically oriented, often well; sterile apices of stromata centric when present	Ectostroma divided in plaques or strips	Species partly intermediate with <i>Hypoxylon</i> with sessile or sub- sessile pulvinate forms, or with sessile or with differentiated stipes, or with perithecia evident to base (cf. section Entoleuca)			<i>X. foriana</i> <i>X. lanthovelutina</i>	K. heliscus
						X. curta	
						X. polymorpha X. mali	
Stroma without black or carbonaceous ectostromal layer		Ectostroma continuous	Species always distinctly spatulate, without hypoxylloid forms	Dark mycelium prominent on coremia; coremia usually aristate only	Conidiophores in palsade formation only	spiral germ slits on ascospores	<i>X. anisopleura</i> <i>X. cornudamae</i>
						<i>X. fejeensis</i> <i>X. gracilina</i> <i>X. leprosa</i> <i>X. longipes</i>	
						X. apiculata X. arbuscula X. luteostroma X. hypoxylon X. digitata X. multiplex X. castorea	
Stroma without well-defined ectostroma		Stroma without black or carbonaceous ectostromal layer		Dark mycelium scanty or absent from coremia, or developed in culture; coremia often clavate or spatulate	Conidiophores irregularly arranged	<i>X. cubensis</i> <i>X. myosurus</i> Poronia Punctata	
							Podosordaria hippitrichioides
							Podosordaria nigripes Podosordaria pallens Podosordaria sicula

**Material examined:**

Maire in *Mycotheca boreali africana* 100, in Miller 100; on *Olea europaea* leaves, L'Alma, country not stated, (1912), (NYBG). Martin 675; culture only, ex CBS, Baarn, Netherlands, (1961).

**Cultural characters (See Martin (1967) Plate V:2):**

Colonies felty, with fine texture, uniform, pure white. Margin distinct, entire; hyphae compact. Carbonization extensive; growth rate slow, 1.1 mm/day at 25°C.

Coremia rosy, unbranched or with up to 5 branches, straight aristate or spathulate, mostly carbonized, white initially but later almost uniformly black except for occasional white apices,  $0.2-0.8 \times 1.5-25$  mm, sterile. The structure of the coremium is similar to the *Graphium*-type noted for many species formerly belonging to *Rosellinia* that the writer (1967) placed in *Hypoxylon* section Entoleuca (*H. aquilum*, *H. necatrix* etc.) but the size and length of the coremia agrees with those of other coremia discussed here.

**Microscopic characters:**

Primary mycelium undiagnostic; maximum width of the marginal hyphae  $=1.5\mu$ . Secondary mycelium uniform, close reticulate; hyphae  $2.5-3.1\mu$  in diameter.

**Conclusion**

This study of twenty-eight members of the fleshy genera of the Xylariaceae shows that as a whole they stand well apart from the other groups in cultural as well as stromal characters. Yet the differences between the fleshy genera themselves are much less definable than amongst the corresponding genera with woody or corky structure, as the accompanying table shows (see Table I). One basic cultural type unites these species with an apparently wide range of stromal divergence, possibly indicating a relatively high degree of interrelationship.

The aim of the whole of this work was to present an analytical review of the twenty-one presently recognized genera of the Xylariaceae, in which the characters originally used in classification were evaluated and compared with several of those newly selected or little studied. In this way it has been possible to reduce several taxa by assigning the species to older established genera and by giving clearer definition to generic concepts. Now only twelve genera, in which there is a broad correlation between stromal and conidiophore types, appear to be valid.

More work of an objective nature is required before these genera can be accepted as natural units. Practically nothing is known of the physiological differences which give rise to a specific type of stroma or colony in culture. Until these are known, a natural classification of the Xylariaceae will still remain an intransigent and fascinating problem.

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## A PRELIMINARY SURVEY OF PHENOLIC COMPOUNDS IN THE GENUS *STREPTOCARPUS* (GESNERIACEAE)

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### ABSTRACT

The phenolic compounds were investigated in the leaves of 55 accessions representing 27 species of *Streptocarpus*. A two-dimensional chromatographic technique was employed and a total of 22 compounds was separated out. Because of the relatively few compounds present, evaluation of the results was very difficult and no clear-cut answers to taxonomic problems in the genus emerged. The narrowness of the spectrum of species studied was also a limiting factor in interpreting the results.

### UITTREKSEL

'N VOORLOPIGE ONDERSOEK VAN DIE FENOLIESE VERBINDINGS IN DIE GENUS *STREPTOCARPUS* (GESNERIACEAE). Die teenwoordigheid van fenoliese verbindings in die blare van 55 versamelings verteenwoordigend van 27 soorte van *Streptocarpus* is ondersoek. 'n Twee-dimensionele chromatografiese metode is vir die doel aangewend en 22 verbindings is van mekaar geskei. Die geringe aantal fenoliese verbindings teenwoordig, het die verwerking van die resultate bemoeilik. Gevolglik kon geen definitiewe gevolgtrekkings aangaande taksonomiese probleme in die genus gemaak word nie. Die feit dat slegs 27 soorte ontleed is, het ook hiertoe bygedra.

### INTRODUCTION

Available information indicates that the chromatographic separation of phenolic compounds may provide information that is valuable in supplementing data from other sources for distinguishing species and determining species interrelationships. Phenolic compounds have been investigated in chemotaxonomic studies of a number of genera, including *Baptisia* (Alston & Turner, 1959, 1963), *Trifolium* (Collins & Taylor, 1964); *Lotus* (Harvey & Grant, 1964); *Eucalyptus* (Hillis & Isoi, 1965); *Psoralea* (Ockendon, Alston & Naifeh, 1965); and *Medicago* (Simon, 1967; Simon & Goodall, 1968).

In the genus *Baptisia*, it was demonstrated that phenolic compounds are more reliable indicators of species relationships than are alkaloids or amino acids (Brehm & Alston, 1964). Harborne (1966) studied the systematic distribution of 3-desoxyanthocyanins in the family Gesneriaceae. His findings supported Burtt's (1962) reclassification of the family into two sub-families on the basis of geographical distribution and the presence or absence of anisocotly.



TABLE 1 (continued)

POLYPHENOLIC COMPOUNDS SEPARATED BY TWO-DIMENSIONAL CHROMATOGRAPHY IN *STREPTOCARPUS* (continued)

SPECIES	LOCALITY	ACCESSION NUMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
<i>S. primulifolius</i> subsp. <i>formosus</i>	Natal, Uvongo River Gorge Natal, Oribi Gorge Natal, Kosiaba, Umintio dist. Natal, Eliesmere, Umintio dist.	30° 50' S, 30° 23' E 30° 43' S, 30° 14' E 30° 21' S, 30° 22' E 30° 19' S, 30° 25' E	•	×	×	×	•	×	×	×	×	×	•	×	×	×	×	×	•	•	•	•	•	•
<i>S. cyanus</i>	Swaziland, Mbabane Swaziland, Hlatikulu Transvaal, Sabie Transvaal, Havelock Border Post	26° 19' S, 31° 8' E 26° 58' S, 31° 19' E 25° 6' S, 30° 48' E 25° 57' S, 31° 6' E	•	×	×	×	×	×	×	×	×	×	•	×	×	×	×	×	•	•	•	•	•	•
<i>S. parviflorus</i>	Transvaal, Louis Trichardt	29° 55' S, 23° 3' E	•	×	×	×	×	×	×	×	×	×	•	×	×	×	×	×	•	•	•	•	•	•
<i>S. sp. aff. parviflorus</i>	Transvaal, Graskop dist.	24° 56' S, 30° 50' E	•	×	×	×	×	×	×	×	×	×	•	×	×	×	×	×	•	•	•	•	•	•
<i>S. gerdii</i>	Natal, Richmond dist. Natal, Inanda dist. Natal, Weza	29° 52' S, 30° 16' E 29° 32' S, 30° 45' E 30° 38' S, 29° 35' E	•	×	×	×	×	×	×	×	×	×	•	×	×	×	×	×	•	•	•	•	•	•
<i>S. johannis</i>	E. Cape, Lusikisiki dist. Natal, Weza	31° 28' S, 29° 38' E 30° 38' S, 29° 35' E	•	×	×	×	×	×	×	×	×	×	•	×	×	×	×	×	•	•	•	•	•	•
<i>S. bauderit</i>	E. Cape, Matatiele E. Cape, Bashee River Valley E. Cape, East London	30° 19' S, 28° 48' E 32° 15' S, 28° 56' E 32° 56' S, 28° 4' E	•	×	×	×	×	×	×	×	×	×	•	×	×	×	×	×	•	•	•	•	•	•
<i>S. polyanthus</i>	Natal, Pietermaritzburg	29° 35' S, 30° 35' E	•	×	×	×	×	×	×	×	×	×	•	×	×	×	×	×	•	•	•	•	•	•
<i>S. proluxus</i>	Natal, Inanda dist. Natal, Ndwedwe dist.	29° 32' S, 30° 45' E 29° 34' S, 30° 56' E	×	×	×	×	×	×	×	×	×	×	•	×	×	×	×	×	•	•	•	•	•	•
<i>S. proluxus</i> × <i>S. polyanthus</i> subsp. <i>verecundus</i>	Natal, Inanda dist.	29° 32' S, 30° 45' E	•	×	×	×	×	×	×	×	×	×	•	×	×	×	×	×	•	•	•	•	•	•
* <i>S. penheterianus</i>	Natal, Paulpietersburg dist.	27° 25' S, 30° 48' E	•	×	×	×	×	×	×	×	×	×	•	×	×	×	×	×	•	•	•	•	•	•
SUBGENUS STREPTOCARPELLA																								
<i>S. hilsenbergii</i>	Madagascar	C 4619	•	×	×	×	×	×	×	×	×	×	•	×	×	×	×	×	•	•	•	•	•	•
<i>S. glandulosissimus</i>	<i>ex hort.</i> Hilliard	Source unknown	•	×	×	×	×	×	×	×	×	×	•	×	×	×	×	×	•	•	•	•	•	•
<i>S. caulescens</i>	Kenya	C. 1737	•	×	×	×	×	×	×	×	×	×	•	×	×	×	×	×	•	•	•	•	•	•
<i>S. saxorum</i>	Tanzania	C. 2908	•	×	×	×	×	×	×	×	×	×	•	×	×	×	×	×	•	•	•	•	•	•

\*Denotes plants collected in the wild.

†H &amp; B indicates Hilliard and Bauderit.

Note: Where the phenolic compounds of a number of accessions are the same, the accessions are bracketed and the phenolic compounds are given only once in the Table.

In the present study the phenolic compounds in a number of taxa of *Streptocarpus* (Gesneriaceae) were investigated, to see whether they might throw any light on species limits and relationships in this taxonomically difficult genus.

Simon and Goodall (1968) have commented at some length on the use of two-dimensional chromatography and the problems encountered in chemotaxonomy. Greater resolution is to be expected from the use of a two-dimensional chromatographic technique. However, the identification of most, if not all, the observed compounds is beyond the scope of most biological investigations. However, according to Alston and Turner (1963) this limitation by no means eliminates the possibility of obtaining a great deal of useful systematic information. According to Simon and Goodall (1968) the number of compounds which can be detected is so much increased in comparison with one-dimensional chromatography, that this factor alone would allow for a better differentiation of taxa. Correct evaluation of the results is a difficult problem. Tabular listings are difficult to assess, particularly if the number of taxonomic units and compounds detected is large. The results of chemotaxonomic studies are generally evaluated on the basis of the presence or absence of compounds and for this reason, methods based on binary similarity indices have been applied (Simon & Goodall, 1968). Ellison, Alston and Turner (1962) proposed a method of expressing and visualizing quantitative relationships of species. These authors used the Jacquard similarity index, which they called the "paired affinity index" viz., 
$$\frac{\text{Spots in common for species A and B}}{\text{Total spots in A and B}} \times 100.$$
 They compared species of

*Bahia* and related genera and expressed the quantitative relationships in the form of polygonal graphs. Harvey and Grant (1964) used a similar approach in a chemo-taxonomic study of the genus *Lotus* and they found that it was of more use in differentiating distantly related taxa, than closely related ones. Simon and Goodall (1968) used the same approach, but found that the similarity values were so high when species belonging to the genus *Medicago* were compared, that the pattern of species relationships was not readily discernible.

## MATERIALS AND METHODS

The phenolic compounds were investigated in 55 accessions representing 27 species of *Streptocarpus*. Unless otherwise indicated in Table 1 the material used was from plants grown together under relatively uniform conditions in a shadehouse. Runemark (1968) maintains that only material cultivated under uniform environmental conditions is suitable for use in chemotaxonomic studies. However, in this study it was found that, within a species, the phenolic patterns of plants from the wild and plants under cultivation corresponded.

Plant material was collected during the summer of 1968/69 and chromato-

graphed within three months of collection. Leaves from each accession were oven-dried at 55–60° for 48 hours. The material was then finely ground and stored in stoppered containers at 0°. The plant material was extracted using the technique of Bate-Smith (1956; 1962). 10 ml 2N HCl was added to a test tube containing approximately 0.5 gm plant material. This was then heated for 20 min in a boiling waterbath. The extract was then cooled, filtered and transferred to a smaller test tube and 0.5 ml iso-amyl alcohol was added. The mixture was shaken vigorously and then allowed to stand for the different layers to separate out. A 50 $\mu$ l aliquot of the hydrolysate from each accession was spotted on each of two sheets of Whatman No. 1 chromatography paper (28 cm  $\times$  23 cm).

TABLE 2

Compounds isolated from two-dimensional chromatograms, their  $R_f$  values and recorded colours

Com- pounds	$R_f$ in:		Colours observed				Identifi- cation
	BAW	Forestal	Visible	Ultra- violet	<i>p</i> -Nitro- aniline	Benedict's	
1	0.53	0.46	purple	purple	—	—	Cyanidin
2	0.56	0.80	—	blue	light brown	yellow	
3	0.81	0.85	—	blue	light brown	yellow	
4	0.91	0.72	—	blue	—	—	
5	0.41	0.56	—	—	—	yellow	
6	0.93	0.76	—	—	—	green-yellow	
7	0.98	0.63	—	—	—	orange	
8	0.28	0.61	—	—	—	yellow	
9	0.46	0.72	—	—	—	yellow	
10	0.74	0.87	—	—	brown	brown	
11	0.88	0.86	—	blue	—	yellow	
12	0.88	0.57	—	—	—	yellow	
13	0.63	0.85	—	purple	brown	bright yellow	
14	0.76	0.84	yellow	blue	pink	—	
15	0.62	0.82	—	—	—	light pink	
16	0.24	0.65	purple	—	—	—	
17	0.71	0.71	—	—	brown	—	
18	0.17	0.58	—	—	—	yellow	
19	0.98	0.89	orange	purple	orange	orange	Dunnione
20	0.97	0.62	—	—	—	purple	
21	0.34	0.27	—	blue	—	—	
22	0.45	0.79	—	purple	—	yellow	

These were developed using the ascending technique in the following solvents: (a) first phase, in the machine direction of the paper, the organic phase of BAW (butanol—acetic acid—water 4:1:5 v/v); (b) second phase, Forestal solvent (acetic acid—hydrochloric acid—water 30:3:10 v/v). (The papers were equilibrated for 18 hours with the lower phase of the BAW solvent.) After drying, the chromatograms were examined in visible and UV-light. (Hanovia Chromatolite, 2537Å). One replicate was sprayed with diazotized *p*-nitro-aniline reagent (Swain, 1953) and the other with Benedict's reagent prepared according to Hänsel (1959).

## RESULTS AND DISCUSSION

Preliminary work in this investigation was done using a one-dimensional chromatographic technique. However, insufficient resolution was obtained and these results have been omitted. A two-dimensional technique was then used because of the greater resolution to be expected.

However, it was still found that relatively few phenolic compounds were separated out. Their positions on the chromatogram are given in Fig. 1. Their  $R_f$  values and recorded colours are given in Table 2. If one compares the 66 compounds separated out by Ellison, Alston and Turner (1962) from leaves of species of *Bahia* with the 22 separated out from the leaves of species of *Streptocarpus* in this study, it becomes obvious that the latter must be regarded as being very poor in phenolic compounds. Evaluation of the results, which are given in Table 1, was thus very difficult and no clear-cut answers to taxonomic problems in the genus emerged.

Compound 1 was identified as cyanidin. This pigment gave a purple colour to the abaxial surface of leaves of *S. wendlandii*, *S. molweniensis* and *S. prolixus*. Although it was only found in these three species in the present study, its presence has been reported in numerous species of *Streptocarpus* (Lawrence & Sturgess, 1957). Cyanidin often appears in plants growing under relatively unfavourable conditions. Because of its wide occurrence it is of no value as an indicator of species limits.

Compound 17 is also a pigment and its occurrence seems to be related to the occurrence of cyanidin. These two compounds, together with dunnione (compound 19) were the only ones which could be distinguished in daylight before the chromatograms were sprayed with a reagent (Table 2). All the other compounds were visible only under ultra violet light or after spraying with one of the reagents.

Compound 4 was identified as coumaric acid and the identification was confirmed using one-dimensional chromatography and comparing the hydrolysates with authentic compounds (Koch Light, England) which were chromatographed under the same conditions.

The results were analysed using the "paired affinity index" and polygonal representation as used by Ellison, Alston and Turner (1962). These results have not been presented as it was found that the similarity values were so high that no pattern of species relationships could be discerned. Nevertheless, a number of interesting facts emerged. Perhaps the most interesting of these is that while compounds 2, 3, 4 were present in all the species studied (27 out of a total of about 145 in the whole genus), compound 6, common to all the true *Streptocarpus*, was absent from the species belonging to the sub-genus *Streptocarpella* (4 studied out of a total of about 40).

A number of species showed a common pattern of phenolic compounds; viz. 2, 3, 4, 6, 7, 8, 9. These were the three accessions of *S. rexii* from E. Cape; two accessions of *S. primulifolius* from Harding dist. and Pietermaritzburg dist., Natal; *S. primulifolius* subsp. *formosus* from Ellesmere, Umzinto dist., Natal; the two accessions of *S. cyaneus* from Swaziland and the two from the Transvaal; a hybrid *S. rexii*  $\times$  *S. gardenii* from Weza, Natal; and the accessions of *S. gardenii* from Inanda dist. and Richmond dist., Natal. The fact that *S. rexii*, *S. primulifolius*, and *S. cyaneus* have a common phenolic pattern is, perhaps, not surprising as these very closely related taxa could well be regarded in the broad sense as being one species (Hilliard & Burt, 1969). *S. gardenii*, taxonomically close to *S. rexii* and its allies, is also very closely related chemically.

There is considerable variation in the phenolic patterns shown by the different accessions of *S. primulifolius* subsp. *formosus*. These accessions show some morphological variation and this is apparently paralleled in their phenolic patterns. The accessions of *S. primulifolius* show three different phenolic patterns which appear to be related to their geographical distribution. The two accessions from Natal have compounds 2, 3, 4, 6, 7, 8, 9; the accession from Bashee River (The Haven), E. Cape has compounds, 2, 3, 4, 6, 7, 8, 9, 10, 15 and the accession from Port St. Johns (situated between the other two localities) has compounds 2, 3, 4, 6, 7, 8, 9, 15

Although *S. candidus* is taxonomically distinct from the *S. rexii*, *S. cyaneus* and *S. primulifolius* group, it appears to be closely related chemically and shows the same phenolic pattern as *S. primulifolius* from Port St. Johns, E. Cape.

A similar phenolic pattern is shown by *S. primulifolius* subsp. *formosus* (Natal, Rosslea, Umzinto dist.), *S. sp. aff. parviflorus* (Transvaal, Graskop) and *S. baudertii*, (E. Cape, Bashee River Valley). The chemical similarity of the first two is understandable on taxonomic grounds: *S. parviflorus* is closely related to *S. cyaneus* and thus to *S. primulifolius* and *S. rexii*, but *S. baudertii* is morphologically very different (Hilliard & Burt, 1969).

*S. pole-evansii* and *S. dunii* were the only accessions to have compound 19 which is known to be the pigment dunnione. This is in agreement with the

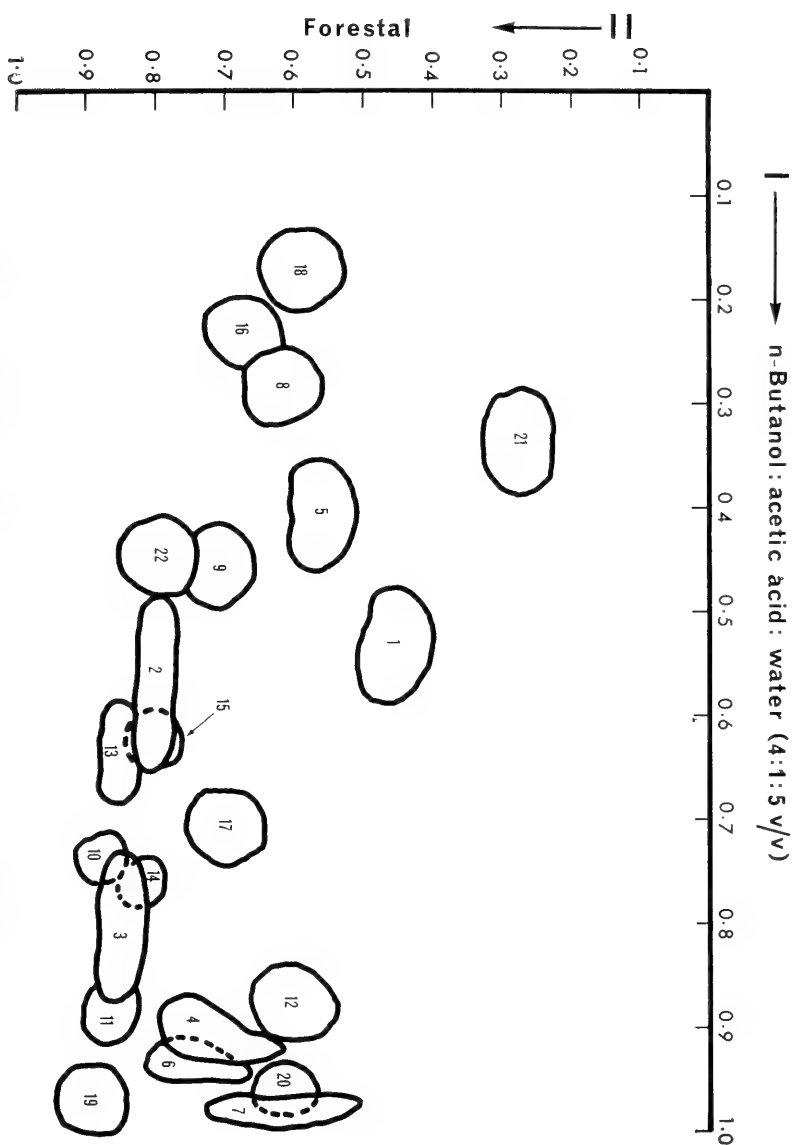


FIG. 1. Master chromatogram showing the position of each of the 22 compounds observed.



findings of Harborne (1966). The pigment is extruded as red granules over much of the epidermal layer.

*S. kentaniensis* and *S. trabeculatus*, both distinctive and taxonomically isolated species, have unique phenolic patterns. This appears to be true of *S. grandis* too, but none of its close allies have been investigated. This serves to emphasize that the narrowness of the spectrum of species studied is also a limiting factor in interpreting the results.

Any future work on the phenolics of *Streptocarpus* should be done so as to include a far wider range of species than was done in this preliminary survey. Interesting work also remains to be done to compare the phenolic patterns obtained from flowers with those obtained from leaves.

#### ACKNOWLEDGEMENTS

The authors are very grateful to Dr. O. M. Hilliard of the University of Natal, Pietermaritzburg for supplying the plant material and for her helpful criticism and advice in the interpretation of the results. Thanks are also due to Dr. K. D. Gordon-Gray, University of Natal, Pietermaritzburg; Dr. F. Gettliffe, University College, Durban and B. L. Burt Esq., Royal Botanic Garden, Edinburgh, for reading the manuscript and for their helpful criticism.

This research was partly facilitated by a grant from the Council for Industrial and Scientific Research, Pretoria, South Africa.

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## A KEY FOR THE GENUS *ERICA* L. USING EDGE-PUNCHED CARDS

H. A. Baker

### ABSTRACT

The need for a flexible key for a large and incompletely known genus and a method of adapting the punched card system for such a purpose is discussed. An application for the genus *Erica* is reviewed with recommendations from experience in its use.

### UITTREKSEL

Die behoefte aan 'n aanpasbare sleutel vir 'n groot, onvolledige bekende geslag en 'n metode om 'n ponskaartstelsel hiervoor aan te pas word bespreek. Die toepassing op die geslag, *Erica* word behandel met aanbevelings voortspruitend uit gebruiksondervinding.

### INTRODUCTION

### ERRATUM

Journal of South African Botany, 35, 6, 1969.

Page 365, line 8: for 32177 read 32117

present study measures approximately  $25 \times 17$  cm and in addition to the printed information has 168 numbered holes punched close to the margin. The states of the most important key characters are shown by whether or not certain corresponding holes have their sides punched so that they are open to the margin (Fig. 1). The cards are sorted in the usual manner by bringing the cards together and inserting a needle in a hole corresponding to a character which is known in the specimen, dividing the pack and continuing with other characteristics until only one or a few cards are left.

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Accepted for publication 27th April, 1970.

arranged chronologically by basionyms. Whenever possible, the types of the basionyms should be cited, e.g.:

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Botanical Library, 1966, should be followed. Periodical titles should be underlined once (for italics). If an author is unable to determine the correct abbreviation of a journal title he is advised to type it out in full and leave its abbreviation to the editor. Titles of **books** should be underlined and given in full, together with the place of publication, name of the publisher and an indication of the edition if other than the first; e.g.:

Davis, P. H. and Heywood, V. H., 1963. *Principles of Angiosperm Taxonomy*. Edinburgh and London: Oliver and Boyd.

Riley, H. P., 1960. Chromosome numbers in the genus *Haworthia*. *Jl S. Afr. Bot.* **26**: 139-148.

## A KEY FOR THE GENUS *ERICA* L. USING EDGE-PUNCHED CARDS

H. A. Baker

### ABSTRACT

The need for a flexible key for a large and incompletely known genus and a method of adapting the punched card system for such a purpose is discussed. An application for the genus *Erica* is reviewed with recommendations from experience in its use.

### UITTREKSEL

Die behoefte aan 'n aanpasbare sleutel vir 'n groot, onvolledige bekende geslag en 'n metode om 'n ponskaartstelsel hiervoor aan te pas word bespreek. Die toepassing op die geslag *Erica* word behandel met aanbevelings voortspruitend uit gebruiksondervinding.

### INTRODUCTION

A key of the usual type found in taxonomic monographs was published for the genus *Erica* L. in Thistleton-Dyer's *Flora Capensis*, by Guthrie and Bolus (1909). This key has proved somewhat unsatisfactory for a number of reasons. Firstly, there has been no convenient way of including the leads for the many new species discovered subsequently. Secondly, the 469 species given are arranged in 41 sections, which by their nature call for very finely detailed interpretations in the key, making it generally inconvenient to use. These sections have become all the more difficult to distinguish in the light of further studies of species variation and newly discovered taxa. The system described below has been designed and studied as an alternative.

### A KEY USING EDGE-PUNCHED CARDS

The method that was followed involves the use of a set of cards bearing the species' data, together with a sorting system. Each species' characters are first written in the respective positions on the card (Fig. 1). The card used in the present study measures approximately  $25 \times 17$  cm and in addition to the printed information has 168 numbered holes punched close to the margin. The states of the most important key characters are shown by whether or not certain corresponding holes have their sides punched so that they are open to the margin (Fig. 1). The cards are sorted in the usual manner by bringing the cards together and inserting a needle in a hole corresponding to a character which is known in the specimen, dividing the pack and continuing with other characteristics until only one or a few cards are left.

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Accepted for publication 27th April, 1970.

A portion of the list of characters used in preparing the key in the present case is shown in Table 1. For many properties, several holes had to be used to give a full enough coding of the information. The number of leaves borne at a node may be 2, 3, 4 or 5—6 (or irregular), corresponding to punch-outs at hole numbers 13, 14, 15 and 16 respectively. If a species should vary and have 3 to 4 leaves per node, the punch-out would be at holes 14 and 15 to reflect this variation. For a few properties, only one hole-position is necessary. Leaves may be either viscid (perhaps with some hairs gland-tipped) or not, so that hole 36 would, or would not, correspondingly be punched. The very complex forms shown by some properties, such as corolla-shape, are reflected in the coding by recording the basic structures in one set of holes and giving various qualifications in others.

Some accessory information is not coded but, being written on the card, it can be used as a guide in confirming an identification. This includes data on flowering-time and distribution. It has proved helpful to add references to publications (Fig. 1).

#### USE OF THE KEY

Experience has shown that the following steps should be followed in using the key:

(1) Arrangements of cards: Although the cards need not be arranged in any particular order it has been found that for ease of use they should be arranged into groups thus:—

(a) Major Groups: Group 1—*Syringodea* and *Stellanthé*; Group 2. *Euerica*; Group 3. *Chlamydanthe* and *Platystoma*. These groups are nearly fully reliable but, when the group to which a specimen belongs is in doubt, it will have to be looked for in two groups but very rarely more. In such a case the groups should be kept separate to avoid mixing up the cards.

(b) Leaf-arrangement Groups: The cards of each Major Group are divided into those having 2-3-nate; 4-nate; 5-6-nate or irregular leaf arrangements.

(c) Ease-of-handling Groups: After dividing up the pack as above a special, deeper, plain card is placed between each major group and between the various leaf groups. Then further plain cards are placed between each group of about 25—30 cards, a number suitable for handling at one time. If too many are taken together on the needle one or more may fail to drop out.

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FIG. 1.

A copy of one of the edge-punched cards used for the key of *Erica* L.  
Slightly reduced.



Flora of Cape Peninsula No. 359 Sp. Nov.  
ERICA ADUNICA Benth., in O.C. Prodr. 7: 618 (1838)  
Sub-genus IV CHLAMYDANTHE Section 3.0 G. e. s. s. o. s. t. a. g. i. a  
Habit of Plant 1 Height 4.5 cm. or so.

Stem and Branches 9  
Leaves 14, 17-18 (linear-subulate-oblong), 2.44 (erect to squarose), 2.7, sub. 2.9, 3.1, 3.4, 2.6-5 mm.  
Inflorescence 39, 44, 147 Peduncles 52-53 (H. o. c. c. o. s. s. o.), 2 mm.  
Bracts 57 (submembrane) 60 usually smaller  
Sepals 65 (membrane), acute 6.8, 7.2, 7.5, 8.0, 8.1, white, 3 mm

Corolla 82, 84, 103, 104, 96 3-3.5 mm. usually longer than the sepals, occasionally less, lobes  
to pale pink. Lobes 10, 11.5, short  
Filaments 120, slightly 119, broadest in middle Anthers 123, 125, 126, 131, 138, 140, slightly 132  
(curved), 136, 1/3-1/2 mm.; pore 3/8 of cell.

Appendages Awns

Crests Style 162 generally decurved.

Ovary 655, in a black disc, 159 or 160 (hypidulous)

Stigma 166 to sub 167

Flowering Season Spring and summer Sept. - Mar.

Distribution Cape Prov. Swellendam, Riversdale, George, Uniondale Districts. Mountains

to 750 m. or so. Garcia Pass, Montagu Area.

Remarks and Varieties Variable in some respects but may be recognized by the loose

sepals, deflexed style (in mature flowers) and the prominent, dark disc below

the ovary.

(2) The specimen must be carefully dissected and the main characters recorded. Upon the accuracy of this the success of the operation will depend.

(3) The major group and leaf-arrangement group in which to work having been decided on, one of the most reliable or unusual (if any) characters is chosen first. It is not desirable to use difficult or obviously unreliable characters until the latest stages. Such are the hairiness of the stem and the leaves, often variable with age. In such cases the youngest parts should be scrutinized. The hole applicable is ascertained from the list and then a group of cards is taken out and carefully squared up so that the holes register properly. The needle is inserted through the relevant hole and the cards having that feature are shaken out. Care must be taken that all such cards have fallen out.

In certain cases, as explained in (8) below the cards that do not fall out are those required.

(4) The process is repeated for all cards in the major group and leaf-arrangement group that is in use.

(5) All the cards that have been collected in (4) are put through a similar process with other reliable characters until (7) is reached.

(6) In doing the above, two or more characters can be used consecutively for each lot of cards but, if too many are used, mistakes are very liable to occur.

(7) Finally, and often quite quickly, the cards will be reduced to one or none. In the first case this should be the species sought if no error has been made. Now, any characters punched out but not yet used must be checked with the specimen. If the result is still favourable—well and good—but, if not, the following procedure must be followed as if no cards had been retained. This fact may indicate a new species but, before deciding on this, the whole operation should be repeated, preferably in a different sequence, but still avoiding the use of doubtful characters until the end. Then, if the result is the same it should be verified that the correct major group has been used and, if there is any doubt, the process repeated for another group.

(8) When a hole has been allotted to two opposite characters, one of which must always be present, the list has been marked thus:— 47. Corolline,/Calycine. If the specimen is calycine the card will have /47 on the line for inflorescence. In such a case the cards retained on the needle from the hole 47 are those required.

(9) When there is doubt, e.g. when a corolla is subcalycine, do not use this character.

## DISCUSSION AND CONCLUSIONS

In using the edge-punched cards for about 700 species of *Erica* L. it has been found that the method is both rapid and effective. As no particular sequence of characters has to be used, the system can be adapted to a variety of situations. If the unknown specimen lacks some features through absence or damage, the ready use of others allows identification to proceed satisfactorily. Identification is particularly rapid when very unusual property-states are found in the specimen and used. Cards for newly described species and varieties are readily added and the card pack can be kept more or less fully up-to-date.

It can be concluded that the method of using edge-punched cards for keys for larger genera may be advocated for use by specialists and larger herbaria. However, the cost of its reproduction might hinder the issue of such a key for wider use.

## REFERENCES

THISTLETON-DYER, W. T., (Ed.) 1905. *Flora Capensis* IV (1): 1-315. London: Lovell Reeve & Co.

TABLE 1.

An extract from the list of characters used in the edge-punched card key for *Erica* L., with the corresponding hole numbers for the coding.

Character	Hole No.
Stem & Branches	
„ „ „ glabrous or glabrescent	8
„ „ „ + or — pubescent or hispid	9
„ „ „ floccose, pilose, hirsute, tomentose, villous or woolly	10
„ „ „ viscid or some hairs gland-tipped	11
„ „ „ with prominent leaf scars, cushions or channels	12
Leaves	
„ 2-nate, usually opposite	13
„ 3-nate	14
„ 4-nate	15
„ 5-6-nate or irregular	16
„ slender, linear	17
„ wider and + or — rigid	18
„ leathery, bladder-like	19
„ very long	20
„ very short	21
„ long-petioled and/or tremulous	22
„ adpressed to the stem	23
„ erect to spreading	24

<i>Character</i>		<i>Hole No.</i>
Leaves		
„	recurved	25
„	incurved	26
„	sulcate	27
„	+ or — open-backed with revolute margins	28
„	keeled, round-backed, trigonous or terete	29
„	not, or scarcely, imbricate	30
„	glabrous	31
„	pubescent or hispid	32
„	floccose, pilose, hirsute, tomentose, villous or woolly	33
„	at least the younger, ciliate or with glands on the margins	34
„	setose-ciliate or toothed	35
„	viscid or with some hairs gland-tipped	36
„	mucronate, aristate, apical or tipped with a bunch of hairs	37
Inflorescence		
Flowers mostly		
„	„ Solitary or in pairs	38
„	„ 3-nate	39
„	„ 4-nate	40
„	„ umbellate to clustered or irregular	41
„	„ capitate, in tight heads	42
„	„ + or — spicate or pseudo-racemose	43
„	„ terminal on branches or branchlets	44
„	„ In the leaf axils or appearing to be so by abortion of the branchlets	45
„	„ 44 and 45 on same plant	46
„	„ corolline,/calycine	47
„	„ cernuous	48
„	„ very numerous	49

## STAPELIEAE (ASCLEPIADACEAE) FROM SOUTH TROPICAL AFRICA: VI

L. C. Leach

### ABSTRACT

*Caralluma lutea* N.E. Br. and its relationship with such species as *C. lateritia* N.E. Br., *C. nebrownii* Berger, *C. vaga* (N.E. Br.) White & Sloane and *C. knobelii* (Phillips) Phillips, is discussed in detail.

One new combination, *C. albocastanea* (Marl.) Leach, is made and several names reduced to synonymy under *C. knobelii* and *C. lutea*, of which latter two subspecies are recognised.

Closely related species such as *C. melanantha* (Schlecht.) N.E. Br. and *C. valida* N.E. Br. are also considered.

A key to the taxa dealt with is provided, together with a map showing their known distributions.

### UITTREKSEL

*Caralluma lutea* N.E. Br. en die verwantskap met soorte soos *C. lateritia* N.E. Br., *C. nebrownii* Berger, *C. vaga* (N.E. Br.) White & Sloane en *C. knobelii* (Phillips) Phillips word breedvoerig bespreek.

Een nuwe kombinasie, *C. albocastanea* (Marl.) Leach word gemaak en verskeie name verlaag tot sinonieme onder *C. knobelii* en *C. lutea* met erkenning van twee subspecies vir laasgenoemde.

Naverwante soorte soos *C. melanantha* (Schlecht.) N.E. Br. en *C. valida* N.E. Br. word ook oorweeg.

'n Sleutel tot die taxa word voorsien, vergesel van 'n kaart waarop die verspreiding aangegee word.

The classification of the group of Carallumas from South Tropical Africa, in the *Caralluma lutea* N.E. Br. relationship, including *C. nebrownii* Berger, *C. vaga* (N.E. Br.) White & Sloane, *C. melanantha* (Schlecht.) N.E. Br. etc., presents some rather difficult problems.

The taxa involved are all apparently quite closely related, yet such is the extent of their variability that individual specimens of one species, considered in isolation have, in the past, been placed not only in different species but sometimes in different genera.

Throughout this paper a broad view of the species has been taken; not to have followed this policy would have resulted in the recognition of almost innumerable taxa, since it seems that within some species, not only are no two specimens identical but that the range of variation within even small populations may be almost unbelievably wide, e.g. *C. lutea* subsp. *lutea* in the vicinity of Bulawayo, Rhodesia.

Similar variability appears to occur almost throughout the genera comprising the tribe [cf. Leach & Plowes in Jl S. Afr. Bot. 33: 99 (1967), when discussing

*C. keithii* R. A. Dyer], and has, no doubt, been largely responsible for the extent of the synonymy with which it is presently burdened.

Robert Brown's original distinction between the coronas of *Stapelia* and *Caralluma* (i.e. "*corona duplex*" and "*corona simplici serie 10-phylla*") appears to the writer, at least in the present context, to be sufficiently explicit; however, in N. E. Brown's note to his expanded diagnoses of the genera in Flora of Tropical Africa 4 (1902), the position seems to be made perfectly clear.

In view of Huber's proposed transfer of some members of the group to *Stapelia* (Asclepiadaceae, Prodr. Fl. S.W. Africa 114, 1967) it is thought to be worth while to quote the relevant portions of N. E. Brown's note.

"The majority of species of *Caralluma* are easily recognised . . . by the outer corona being cupular or its lobes forming 5 small pouches, a few species, however . . . cannot be technically distinguished from *Stapelia*."

On this basis it seems that, however difficult may be the decision in respect of a "few species", there seems no doubt whatever that the taxa now under consideration belong in *Caralluma* as presently constituted.

It seems that there are two groups, falling under the present heading, which may be distinguished by the form of the inner lobes of their coronas, viz:

- (1) The "lutea group" with the inner coronal lobes laterally compressed.
- (2) The "valida group" in which these lobes are dorsi-ventrally compressed (i.e. strap-like) or stoutly subulate (sometimes + terete).

#### KEY TO THE ACCEPTED TAXA

Corolla lobes narrowly or very narrowly attenuate, narrowly ovate-attenuate or narrowly triangular, (2·8) 3 to 5 (7·4) times as long as wide.

Inner corona lobes distinctly 2-horned, the horns spreading-erect, falcate; the inner lobes laterally much compressed, the outer similarly compressed or subconical  
1a. *C. lutea* subsp. *lutea*

Inner corona lobes simple, subulate obtuse, or sometimes dorsi-ventrally compressed (strap-like) then usually shortly bifid at the apex

Corolla less than 60 mm in diameter

Corolla lobes ciliate, relatively coarsely pubescent and usually to some extent bristly on the inner surface; outer corona lobes suberect, inner lobes strap-like, erect, recurved, usually shortly bifid at the apex  
5. *C. valida*

Corolla lobes not ciliate; corolla not bristly; outer corona lobes spreading, inner lobes simple, subulate, incumbent on the anthers, recurved at the connivent apices  
6. *C. tsumebensis*

Corolla more than 60 mm in diameter; pubescence microscopic; inner corona lobes subulate, incumbent on the anthers, connivent, recurved at the apex

Corolla lobes ciliate . . . . . 7. *C. huillensis*

Corolla lobes not ciliate . . . . . 8. *C. gossweileri*

Corolla lobes ovate to broadly ovate or triangular to broadly triangular, acute or shortly acuminate

Corolla lobes 1·4 to 3 (usually  $\pm 1\cdot8$ , very rarely 4·3) times as long as broad

Inner corona lobes somewhat excavated or subfurcate at the much broadened gibbous base, often echinulate or irregularly minutely gibbous

4. *C. melanantha*

Inner corona lobes laterally compressed, distinctly 2-horned (very rarely with the outer horn much reduced), neither excavated nor subfurcate at the base, never echinulate

Corolla lobes usually more than 1.7 cm long (very exceptionally 1.2); flowers mostly unicoloured, reddish to blackish purple or rarely yellow, sometimes variegated or yellow spotted or flecked; horns of the inner corona lobes suberect . . . . . 1b. *C. lutea* subsp. *vaga*

Corolla lobes generally less than 1.5 cm long (very exceptionally 2.0); flowers whitish, spotted with red-brown to dark purple

Pedicels more than 3.5 cm long; outer horn of inner corona lobes suberectly spreading, subequalling the inner horn; outer corona lobes  $\pm 2$  mm long  $\times$  1.5 mm . . . . . 2. *C. albocastanea*

Pedicels less than 3.5 cm long; outer horn of inner corona lobes widely (often subhorizontally) spreading, about half the length (or less) of the inner horn; outer corona lobes  $\pm 3$  mm long  $\times$  2 mm . . . . . 3. *C. knobelii*

Corolla lobes  $\pm$  as broad as long (sometimes slightly broader) 0.7 cm to 1.6 cm long

Inner corona lobes somewhat excavated or subfurcate at the much broadened gibbous base, often echinulate or irregularly slightly gibbous . . . . . 4. *C. melanantha*

Inner corona lobes laterally compressed, neither excavated nor subfurcate at the base, never echinulate . . . . . 3. *C. knobelii*

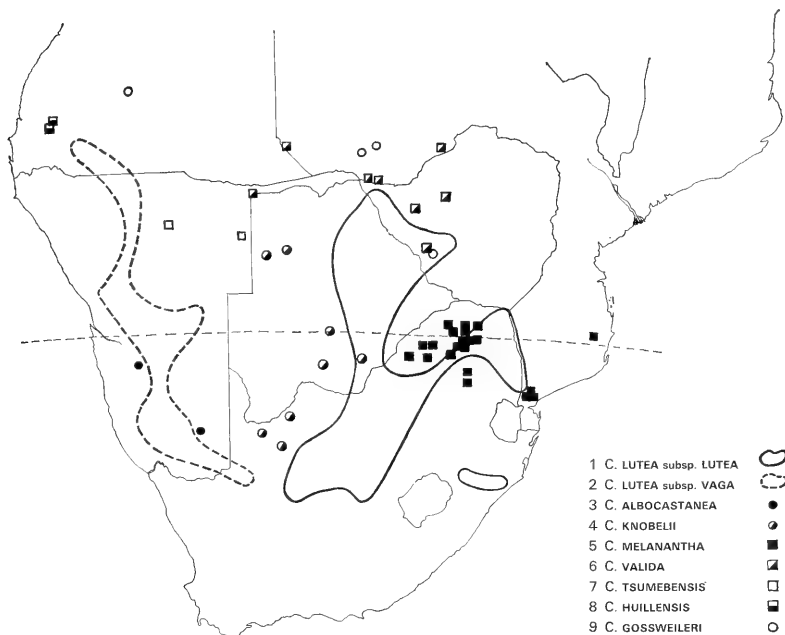


FIG. 1.

Due to the extent of the variability of most of the available characters (those discernible in dried material) it has been found virtually impossible to devise an infallible key. It is advisable therefore to confirm identifications from the locality; in the present instance this is a reasonably accurate procedure since such overlaps as may occur in the key are usually widely separated either spatially or ecologically or both.

Although the groups may be thus satisfactorily broadly divided and the taxa keyed out to subspecific level the taxonomic problems involved are by no means as simple of solution; particularly is this so in the "lutea group".

While the "valida group" appears perhaps to be the more variable, the problems involved seem to be rather more tractable (possibly only appearing so because of the relative paucity of material available). Despite the exasperating nature of this material, in which no two specimens are really alike, the taxa seem to be more readily separated into groups which are quite distinct, at least in those areas where their respective distributions impinge.

The situation in respect of this group has also been confused by the reputed pubescence of the stems of *C. huillensis*, an error which appeared to distinguish that species from all others in the group, when it is, in fact, very close indeed.

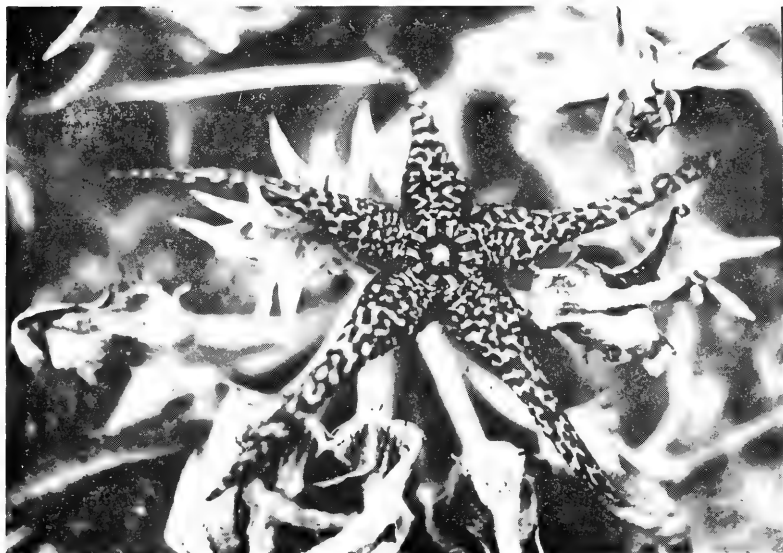
It seems probable that the "valida group" should be considered as representing two very variable species but it is considered that there is insufficient material available, in view of its variability, to provide logical bases for the delimitation of the subordinate taxa which, on present evidence, would appear then to require recognition. It is considered therefore, to be preferable to discuss the situation on the basis of the presently recognised species rather than to propose nomenclatural changes based on what is considered to be inadequate evidence.

#### **Caralluma lutea** N.E. Br. complex

Excluding *C. albocastanea* (Marl.) Leach and *C. knobelii* (Phillips) Phillips with its synonyms, which although apparently of common ancestry, are considered to be sufficiently differentiated to be recognised at specific level, as well as the quite distinct *C. melanantha* (Schlecht.) N.E. Br., we are left with a very variable complex which includes, at first sight, several apparently readily distinguishable taxa.

However, Phillips in Flower. Pl. S. Afr. **16**: t.621 (1936), correctly in my opinion, considered *C. vansonii* Bremek. & Oberm. to be merely a large-flowered form of *C. lutea*; while *C. lateritia* was reduced by Nel, in White & Sloane's monograph of 1937, to varietal status in the same species. Now that shaded bicoloured and variegated flowers, as well as unicoloured of various colours and shades are known, it seems that even this varietal distinction must fall away and *C. lutea* be recognised as being extremely variable as to both size and colour.





*Mrs. W. Bullock 90g*

Plant with heavily variegated flowers, dark maroon and yellow, from near Bulawayo, Rhodesia.

*Photo by courtesy of Mr. E. J. Bullock*



*Plowes 1877*

Plant with red-maroon flowers with yellow flecks and wide corolla lobes.

*Photo L. C. Leach*



*Wild & Drummond 7224*

Plant with flowers shaded from maroon to yellowish pink and very narrowly attenuate lobes, flowering between Rakops and Lake Dow, Botswana.

*Photo by courtesy of Prof. H. Wild*

FIG. 2. *Caralluma lutea* N.E. Br. subsp. *lutea*.

Typical *C. lutea* and *C. vaga* (N.E. Br.) White & Sloane, as represented by the S. African and Ovamboland populations respectively might well be considered to have reached a stage of development where differentiation would justify recognition as distinct species. However, the overall similarity, especially in coronal characters, when considered against the background of the apparently clinal nature of the variations exhibited by the intermediate populations, leads one inescapably to the conclusion that recognition at subspecific level is the only logical course, the two taxa seeming to be distinguished only by the respective proportions of their corolla lobes.

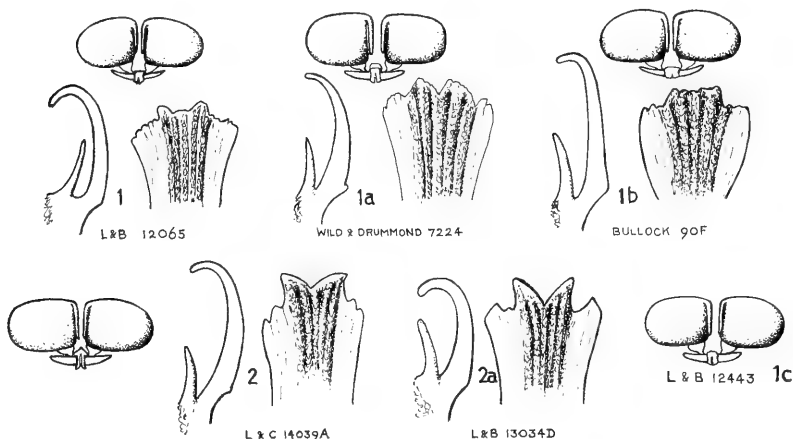


FIG. 3. *Caralluma lutea* N.E. Br.

Corona lobes  $\times 5$  approx.

Pollinia  $\times 15$  approx.

Subsp. *lutea*.

1. Hammanskraal, Pretoria Distr., Transvaal ("lutea").

1a. Between Rakops and Lake Dow, Botswana ("vansonii").

1b. Near Bulawayo, Rhodesia ("lateritia").

1c. Near Mafeking, Northern Cape ("lutea").

Subsp. *vaga*.

2. Cahama, Huila Distr., S. Angola.

2a. Ondangua, Ovamboland, S.W. Africa.

There are two intermediate populations: one in S.W. Africa and the other in Rhodesia and Botswana, separated by the Kalahari where the closely related *C. knobelii* occurs. The Botswana and Rhodesia population is by far the more variable as to colour, but in shape and proportions of the corolla quite clearly belongs in subsp. *lutea*, typical examples of which overlap the intermediate population in some areas, so that no territorial division is possible.

The position regarding the S.W. African intermediate population, which includes *C. nebrownii* Berger and the variety *pseudonebrownii* (Dinter) White & Sloane, is not quite so clear-cut. Here plants may be found with corolla proportions closely coinciding with those of the Botswana and Rhodesian plants, while others merge gradually into typical subspecies *vaga*. The territorial separation of the two varieties of *C. nebrownii* as suggested by Dinter does not seem to be supported by the material presently available, so that it becomes quite impossible to separate these from each other or from typical subsp. *vaga*, with the distribution of which there is considerable overlap.

As it seems quite impracticable to give taxonomic recognition to these intermediate populations it is considered that the S.W. African plants are best accommodated in subsp. *vaga*, especially in view of their considerable spatial separation from those intermediate populations referable to subsp. *lutea*. Accordingly *C. nebrownii* has been included in the synonymy of subsp. *vaga*. A very few specimens (mainly from among those with variegated flowers, i.e. var. *pseudonebrownii*) may, on the basis of corolla lobe proportions, key out to subsp. *lutea* but this serves, perhaps, to emphasise the conspecific nature of the taxa.

#### 1a. Subsp. *lutea*

*Caralluma lutea* N.E. Br. in Hooker's Icon. Pl. **10**: t.1901 (1891); Hooker's Gdnrs' Chron. **12**: 370 (1892); Fl. Cap. **4**,1: 885 (1909) et in Curtis's bot. Mag. **135**: t.8265 (1909).—Berger, Stap. ü. Klein.: 84 (1910).—Schlechter in Engl., Bot. Jb. **20**,3: 54 (1895) et in Britten, J. Bot. Lond. **36**: 475 (1898).—K. Schum. in Engl. & Prantl, Pflanzenfam. **4**,2: 278 et fig. 83E & F (1897).—Wilman, Check List Griq. West: 173 (1906).—Phillips in Flower. Pl. S. Afr. **10**: t.379 (1930) et **16**: t.621 (1936).—Marloth, Fl. S. Afr. **3**,1: 97 et Pl. 23 (1932).—Bremek. & Oberm. in Ann. Transv. Mus. **16**: 428 (1935).—White & Sloane, Stap. **1**: 360 (1937).—Hutch., Botanist S. Afr.: 426 (1949).—Luckhoff, Stap. S. Afr.: 61 (1952).—Jacobsen, Handb. Succ. Pl. **1**: 249 et fig. 238 (1960).—Letty, Wild Flower. Transv.: 264 et fig. 130 (1962).

Syntypes: "From the Transvaal country" *Sanderson* s.n. (K!); *Mrs. Barber*; Klip Drift, *Tuck* in *MacOwan* 2240 (K!); Diamond Fields, *Tuck* hort. *MacOwan* 2240 (G-DC! K! PRE! SAM!); Griqualand West, *Bowker* in *Barkly* 7 (K!); Du Toit's Pan, *Barkly* 40 (K!).

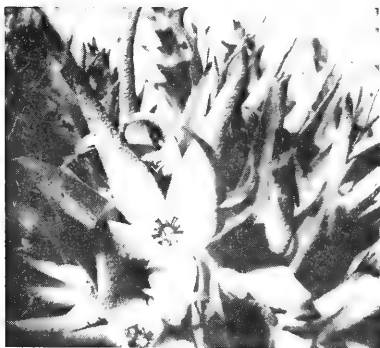
Lectotype: Klip Drift, *Tuck* in *MacOwan* 2240 (K!).

*Tuck* in *MacOwan* 2240 has been selected as the lectotype as not only are there several specimens under this number in various herbaria, but also a pen sketch with some loose flowers on a sheet at Kew which appears possibly to have been the base of N. E. Brown's description.

*Plowes 1705**Plowes 1943*

Maroon flowered plants, one yellow spotted, from Lucydale Farm, Matopos, Rhodesia, shewing variation in corolla lobe width.

*Photo by courtesy of Mr. D. C. H. Plowes*

*Leach 9770*

Plant with yellow flowers and maroon striped corona from near Pietersburg, Transvaal.

*Photo L. C. Leach*

*Plowes 1529*

Plant with pale red flowers and maroon striped corona from Nyamandhlovu, Rhodesia.

*Photo L. C. Leach*

FIG. 4. *Caralluma lutea* N.E. Br. subsp. *lutea*.

It seems possible that all the specimens under this number were cultivated by MacOwan and that the most likely wild locality was Klip Drift (now Barkly West) as this was cited by Miss Wilman in her Check List (*l.c.*) as well as being the only precise locality mentioned on the sheets at Kew (the SAM specimen is indicated as being from Dutoitspan, but is the only *Tuck* specimen so located).

*Caralluma lateritia* N.E. Br. in Flora trop. Afr. **4**, 1: 486 (1903).—Berger, op. cit.: 86 (1910).—Eyles, Trans. R. Soc. S. Afr. **5**: 451 (1916).—White & Sloane, tom. cit.: 370 (1937).—Luckhoff, op. cit.: 33, 64 (1952).—Jacobsen, tom. cit.: 248 (1960).

Type: Botswana, Ngamiland, Botletle Flats, *Lugard* 307 (K!).

*Caralluma vansonii* Bremek. & Oberm. in Ann. Transv. Mus. **16**: 429 (1935).—White & Sloane, tom. cit.: 364 (1937).—Jacob., tom. cit.: 257 (1960).

Type: Botswana, Nkate, Nata River, *Van Son* (PRE!).

*Caralluma lateritia* var. *stevensonii* White & Sloane, tom. cit.: 371 (1937).—Jacob., tom. cit.: 248 (1960).

Type: Rhodesia, Wankie Distr., Matetsi, *Stevenson* (no material traced).

*Caralluma lutea* var. *lateritia* (N.E. Br.) Nel, in White & Sloane, tom. cit.: 373 (1937).—Jacob., tom. cit.: 249 (1960).

Type: As for *Caralluma lateritia* N.E. Br.

*Caralluma lutea* var. *vansonii* (Bremek. & Oberm.) Luckhoff, op. cit.: 62, 63 (1952).

Type: As for *Caralluma vansonii* Bremek. & Oberm.

*Stapelia vaga* sensu Huber in Prodr. Fl. S.W. Afr. **114**: 62 (1967), pro parte quoad syn. *Caralluma lateritia* N.E. Br. et *C. lutea* var. *lateritia* (N.E. Br.) Nel.

Subspecies *lutea* is characterised by its narrowly attenuate corolla lobes which are generally about 3 to 5 times as long as wide, the full range of this ratio varying, in the material seen, from 2·8 to 7·4 : 1, the extremes being, however, of uncommon occurrence.

Number and size of flowers and length of pedicels, whilst very variable, seem to be of no taxonomic significance, although the general trend appears to be for larger flowers and longer pedicels to occur more frequently towards the westerly and particularly the northerly limits of the distribution. The largest flowers and greatest colour variations (from the typical yellow to dark, sometimes almost black, red or maroon) occur in the northern Botswana and Rhodesian populations, in which, although unicoloured corollas predominate, shaded, speckled and variegated flowers are to be found, while plants with contrastingly

coloured and often striped coronas are not uncommon. Colour variation in the southern areas of distribution appears to be limited to varying shades of yellow; collectors' notes recording "mustard", "brownish", "almost green", and rarely "orange", while striped coronas are also to be found.

In the following lists of material seen, specimens are located: for Angola under the Administrative Districts, for the Flora Zambesiaca area under the divisions of the area as set out in Flora Zambesiaca 1 (1960) and for S.W. Africa and S. Africa using the grid system of reference as recommended by the Botanical Research Institute, Pretoria.

Records of gatherings by Leach & Bayliss, Leach, Bayliss & Lamont, Leach & Noel and Leach & Cannell have been abbreviated to L. & B., L., B. & L., L. & N., and L. & C. respectively.

Cult. Greendale and cult. Nelspruit refers to plants grown in the author's gardens at Greendale, Salisbury, Rhodesia and Nelspruit, E. Transvaal, S. Africa.

**BOTSWANA.** N: Rakops, Botletle Flats, Ngamiland, *Lugard* 307 (K). Nkate, Nata Riv., cult. Transv. Mus. No. 28760, fl. March 1931, *Van Son* s.n. (PRE; SRGH). Makarikari Pan, cult. NBG 52/57, fl. 13.iv.1959, *Nat. Mus. Rhod.* in Herb. Compton 28234 (NBG). Gweta, cult. SRGH, No. 4071, fl. Jan. 1967, *Smithers* s.n. (SRGH). Between Rakops and Lake Dow, cult. SRGH, fl. Nov./Dec. 1965, *Wild & Drummond* 7224 (K; PRE; SRGH).

**SE:** ± 40 mls. N of Serowe, cult. SRGH fl. Jan. 1966, *Wild & Drummond* 7280 (K; KIEL; LISC; PRE; SRGH). Serowe, cult. Nelspruit, *L. & B.* 12515 (BR; M; NBG), *L. & B.* 12516 (BM; BOL; G; K; LISC; LISU; MAH; PRE; SRGH; Z), 12516A (K; LISC; MO; PRE; SRGH); *ibid.* cult. SRGH, fl. 1969, *Liversedge* s.n. (K. LISC; PRE; SRGH; WIND). Letlhakeng, cult. Nelspruit, *L., B. & L.* 12489 (B; BOL; FI; K; KMG; LISC; MAH; NBG; PRE; S; SRGH; ZSS). ± 11 mls. N of Gaberones, cult. Greendale, 15.i.1960, *L. & N.* 101 (SRGH), *ibid.* 102 (SRGH). Metsimaklaba, near Gaberones, 9.iii.1930, *Van Son* in Herb. Transv. Mus. 28756 (PRE). Gaberones, 15.iii.1930, *Van Son* in Herb. Transv. Mus. 28755 (PRE). ± 4 mls. S of Gaberones, cult. Greendale, iii.1960, *L. & N.* 94 (SRGH). ± 10 mls. S of Gaberones, cult. Nelspruit, *L., B. & L.* 12485 (COI; FHO; GRA; HEID; J; KIEL). Near Ramoutsa, cult. Nelspruit *L., B. & L.* 12483 (BM; BOL; G; K; LUA; NBG; SRGH), 12484 (STE); Nuane Dam (NW of Lobatsi), cult. Nelspruit, 12460 (BOL; COI; FI; MO). ± 8 mls. N of Lobatsi, cult. Greendale, iii.1960, *L. & N.* 212 (SRGH), ± 3 mls. N of Lobatsi, cult. Greendale, fl. Feb./March 1960, *L. & N.* 122 (GRA; SRGH), 133 (SRGH), 136 (PRE; SRGH), ± 2 mls. N of Lobatsi, 120 (NH; PRE; SRGH). ± 3 mls. SE of Lobatsi, cult. Nelspruit *L., B. & L.* 12472 (BR; LMA; M; NH; PUC; ZSS), 12472B (LISC), 12472D (G), 12472E (K; PRE).

± 3 mls. S of Lobatsi, cult. Greendale, iii.1960, *L. & N. 157* (HEID; SRGH).  
 ± 7 mls. W of Lobatsi, cult. Nelspruit, *L., B. & L. 12464* (B; BM; GRA).  
 ± 10 mls. S of Lobatsi, cult. Nelspruit, *12453* (K; KIEL; KMG; LUAI; M).  
 Baralong, cult. SRGH No. 3719, fl. ii.1968, *Smithers* s.n. (K; SRGH). ± 6 mls.  
 N of Border Gate, cult. Nelspruit, *L. & B. 12447* (LISJC), ± 1 ml. N of Border  
 Gate, *12445A* (J; STE). ± 28 mls. NW of Mafeking, ii.1958, *Acocks 18760*  
 (PRE).

RHODESIA. W: Bulawayo, Feb. 1904, *Eyles 22* (SRGH); "Bulawayo Distr.",  
 Jan. 1921, *Tapscott* s.n. (PRE); Plumtree, 20.x.1936, *Eyles 8763* (K), iii.1949,  
*Davies* s.n. (SRGH); ± 15 mls. NE of Bulawayo, cult. Greendale, ii.1960,  
*Leach 5818* (K; PRE; SRGH); *ibid. Biegel* s.n. (SRGH); Matopos, near  
 Rhodes's Grave, cult. 21.xii.1906, *Ayres in Pillans 51* (BOL); Nyamandhlovu  
 Research Sta., *Plowes 1529* (K; PRE; SRGH); Matopos Research Sta., Burford  
 Farm, ii.1953, *Plowes 1705* (SRGH), x.1955, *Plowes 1877* (PRE), *idem* cult.  
 Nyamandhlovu, xi.1952, *Plowes 1877* (SRGH), *idem* cult. Greendale, *Plowes* in  
*Leach 5555* (K; LISC); Manzimbomvu Riv., Matopos, cult. Umtali, 21.xi.1967,  
*Plowes 1896* (K; PRE; SRGH), cult. Greendale, in *Leach 5561* (BOL; SRGH);  
*ibid.* cult. Nelspruit, 8.xi.1965, *Bullock 53* (BM; LISC); Matopos Research Sta.,  
 Lucydale Farm, 30.i.1967, *Bullock 78* (SRGH); *ibid. Plowes 1943* (M); *ibid.*  
 cult. Umtali, 8.xi.1968, *Plowes 3025* (SRGH); Sibizena Hill, near Matopos  
 Mission, cult. Burnside, 6.ii.1966, *Bullock 54* (BR), *idem* cult. Nelspruit,  
 23.x.1965 (M); *ibid.* cult. Umtali, Nov. 1967, *Plowes 2481* (SRGH); Gladstone  
 Farm, Matopos, cult. Burnside, xii.1965, *Bullock 46* (SRGH); Burnside near  
 Bulawayo, various plants and dates, *Bullock 90* (BOL; K; SRGH), *90A* (K;  
 LISC; SRGH), *90B* (PRE), *90C* (BM; G), *90D* (flowers yellow) (K; LISC;  
 PRE; S; SRGH), *90E* (MAH; NBG; WIND), *90F* (B; COI; FHO; FI; KIEL;  
 LISU; LMA; LUA; LUAI; MO; PUC; Z), *90G* (flowers variegated) (BOL; K;  
 LISC; M; NBG; PRE; SRGH; WIND), *90H* (flowers yellow) (BM; BOL; M;  
 WIND). Without precise locality, *Wilman* s.n. (K).

SOUTH AFRICA. Transvaal, 2231 (Pafuri), Punda Maria (-AC), iii.1933, *Lang*  
 in Herb. Transv. Mus. *31804* (PRE).

2329 (Pietersburg), 8 mls. N of Pietersburg (-CD), cult. Greendale, 24.xii.  
 1969, *Bey 47* (SRGH); 6 mls. E of Pietersburg (-CD), cult. Turfloop, 22.ii.1964,  
*Van Vuuren 1653* (PRE); 15 mls. E of Pietersburg (-DC), cult. Greendale,  
 15.ii.1960, *Leach 9770* (PRE; SRGH).

2331 (Phalaborwa), Letaba (-DC), 27.iii.1933, *Lang* in Herb. Transv. Mus.  
*30618* (PRE), *ibid.* ix.1933, *Lang* s.n. (PRE).

2428 (Nylstroom), Naboomspruit (-DA), *Stent* in Nat. Herb. *11373* (PRE).

2525 (Mafeking), between Zeerust and Gaberones, iii.1934, *Van Son* s.n.  
 (PRE).

2526 (Zeerust), Zeerust, *Knobel* s.n. (PRE); Zeerust, cult. Pretoria, *Leendertz* in Herb. Transv. Mus. 12785 (PRE), *ibid.* *Pott* 4354 (GRA), *ibid.* ii.1919, *Rogers* 22724 (Z); *ibid.* i.1928, *Thode* A1446 (PRE).

2527 (Rustenburg), Northam (-AA), cult. Nelspruit, *Bayliss* in *Leach* 11990 (SRGH); Sanadu (-DD), 10.iii.1933, *Brain* 10375 (SRGH); Brits (-D), 6. iv.1935, *Mogg* 14646 (PRE), *ibid.* 29.iii.1927, *Nouhuys* 6 (PRE).

2528 (Pretoria), 3 mls. E of Hammanskraal (-AD), cult. Nelspruit, 8.ii.1964, *L. & B.* 12065 (SRGH; Z); 20 mls. N of Pretoria, near Rooiplaat (-AD), 7.x.1937, *Erens* 449 (PRE); Pienaars River, Hammanskraal (-A), 27.iii.1933, *White* in Herb. Transv. Mus. 31803 (PRE); Pienaars River (-A), 18.iii.1933, *Schweickerdt* 1059 (COI; PRE); Pretoria (-C), 25.ii.1949, *Anderson* s.n. (NBG); Wonderboom, cult. Pretoria, *Pott* in Herb. Transv. Mus. 19211 (PRE), *ibid.* 13.iv.1951, *Reyburn* s.n. (PRE).

2531 (Komatipoort), Sabi Riv., 1 ml. E of Skukusa (-BA), 4.v.1949, *Codd* 5487 (PRE), *idem.* cult. PRE, iv.1952 (PRE; SRGH).

2724 (Tuang), Kameelpan, Christiana (-DD), 10.i.1934, *Theron* 523 (PRE).

2726 (Odendalsrus), 8 mls. S of Makwassie (-AC), cult. Turfloop, 10.ii.1964, *Van Vuuren* 1653 (PRE).

Without precise locality: "Transvaal" *Holub* (K); "From the Transvaal country" *Sanderson* s.n. (BOL; K).

O.F.S. 2627 (Potchefstroom), near Parys (-CD), *Malcolm* in Herb. Moss. 19622 (J).

2825 (Boshof) Klippiesspan Farm (-C), cult. NBG 149/43, 18.ii.1943, *Harris* s.n. (NBG).

2826 (Brandfort), Brandfort (-CB), cult. NBG 520/54, 12.iii.1956, *Hall* s.n. (NBG).

2925 (Jagersfontein), Fauresmith Bot. Res. (-DA), fl. v.1927, fr. x.1927, *Smith* 3957A (PRE); Fauresmith, *Dyer* 1923 (GRA), 26.i.1930, *Henrici* 1958 (PRE), *ibid.* cult. PRE, iii.1930 *Nouhuys* in Nat. Herb. 8459 (PRE), *ibid.* i.1928, *Smith* 5253 & 5591 (PRE).

2926 (Bloemfontein), Bloemfontein (-AA), 6.ii.1966, *Hanekom* 562 (PRE); *ibid.* *Pott* 391 (BOL) and *Pott* 392 (GRA).

Natal, 2829 (Harrismith), Ladysmith (-DB), cult. NBG 329/46, 14.iii.1949, *Morton* s.n. (NBG).

2830 (Dundee), Weenen (-CC), 24.ii.1965, *Moll* 1671 (PRE), iii.1914, Herb. Justus Thode in Herb. Stellenbosch 2606 (STE); between Greytown and Keats Drift (-DC), xii.1935, *Reynolds* 1713 (PRE).

2831 (Nkandla), Eshowe, 22.iii.1938, *McLoughlin* s.n. (PRE).

Cape: 2525 (Mafeking), Pitsani Farm (-CC), cult. NBG 401/59, 29.iii.1962, *Cole* s.n. (NBG);  $\pm$  3 mls. S of Ramathlabama (-DA), cult. Nelspruit, *L. & B.*



12444 (B; BM; BR; COI; G; K; KIEL; KMG; M; NBG; PRE; SRGH); ± 3 mls. SE of Mafeking (-DC), cult. Nelspruit, *L. & B.* 12443 (BOL; LISC; ZSS); Rooigrond (-DC), cult. Nelspruit, i.1965, *Bayliss* 2032 (NBG; PUC; STE); Mafeking (-DC), iii.1907, *Marloth* 4377 (K).

2624 (Vryburg), Vryburg (-D), cult. *Pillans* 49, *Fry* s.n. (BOL; K).

2722 (Olifantshoek), Olifantshoek (-DD), cult. Nelspruit, Jan. 1968, *L. & C.* 13803A (K; S), 13803B (K; S).

2724 (Taung), Taungs Native Res. (-DA), 26.ii.1946, *Brueckner* s.n. (PRE); W of Harz Riv. (DB), *Rodin* 3623 (BOL; K); Buxton (-D), ii.1948, *Brueckner* 1209 (PRE).

2824 (Kimberley), Warrenton, (-BB), *Adams* s.n. (GRA); 4 mls. SW of Warrenton (-BB), 13.ii.1959, *Leistner* 1256 (PRE); ½ ml. S of Holpan P.O. (-DA), cult. PRE, i.1960, *Leistner* 1415 (PRE); Klip Drift (Barkly West) (-DA), *Tuck* in Herb. MacOwan 2240 (G; K; PRE), idem ?Dutoitspan (SAM), idem, cult. *MacOwan* (K); Spytfontein, ± 8 mls. from Kimberley (-DC), iii.1933, *Schweickerdt* 1119a (PRE); Dutoitspan (-DD), v.1875, *Barkly* 40 (K); Kimberley (-D), *Bolus* 268 (BOL); ibid. 19.iii.1906, *Galpin* 7358 (GRA; PRE); 27.iii.1953; ibid. *Hall* 656 (NGB), *Rehmann* 3480 (Z), *Wilman* 1177 (SAM); Griqualand West, *Bowker* 7 (K).

2922 (Prieska), Prieska (-CB), *Marloth* 3776 (PRE), *Bryant* 878 (K); 7 mls. N of Prieska (-CB), cult. NBG 272/59, 23.ii.1960, *Hall* 1689 (NGB); 15 mls. NW of Prieska (-CB), cult. PRE, *Schlieben* 8794 (PRE).

2923 (Douglas), Mazelfontein (-BA), cult. Albany Mus., *Anderson* s.n. (GRA); Douglas (-BB), *Harries* in Herb. *Galpin* 6308 (PRE).

The distribution of this taxon, which seems to be exceptionally tolerant of widely differing edaphic and climatic conditions, extends from Natal to northern Botswana; its main concentration appearing to be in the northern Cape and south-eastern Botswana, where relatively densely populated colonies are frequently to be found. It is also reliably recorded from Mangulane in the Lourenço Marques District of Moçambique, but unfortunately no material appears to have been preserved nor has it again been collected from this area.

(1b). Subsp. *vaga* (N.E. Br.) Leach, stat. nov.

*Stapelia vaga* N.E. Br. in Kew Bull. 1895: 265 (1895) et in Flora trop. Afr. 4,1: 501 (1905).—Berger, Stap. ü. Klein.: 237 (1910).—Huber in Prodr. Fl. S.W. Afr. 114: 62 (1967), pro parte excl. syn. *Caralluma lateritia* N.E. Br. et *C. lutea* var. *lateritia* (N.E. Br.) Nel.

Type: S.W. Africa, Ovamboland, *Schinz* 2047 (K! Z!). The sheet at Kew is not numbered but there seems little doubt that it is, in fact, a duplicate of that at Zürich.

*Caralluma nebrownii* Berger in Notizbl. bot. Gart. Mus. Berl. **4**: 249 (1906) et Stap. ü. Klein.: 85 (1910).—N.E. Br. in Curtis's bot. Mag. **135**: t.8267 (1909).—Pearson in Ann. S. Afr. Mus. **9**: 183 (1912).—White & Sloane, Stap. **1**: 374 (1937).—Luckhoff, Stap. S. Afr.: 53, 65, 66 (1952).—Jacob., Handb. Succ. Pl. **1**: 252 (1960).

Type: S.W. Africa, Barmen, *Dinter* 1502.

There are several specimens at Kew which are labelled Type or Type Specimen, but judging from the various dates of publication, flowering etc. it seems probable that several plants were involved; however, on the evidence available it seems that the single flower labelled *Dinter* "Type specimen" may well be from Dinter's original gathering No. 1502.

*Caralluma brownii* Dinter et Berger in Dinter, Deutsch S.-W. Afr.: 113 (1909).

*Caralluma pseudonebrownii* Dinter, Neue Pfl. S.W. Afr.: 17 (1914).—Stapf in Curtis's bot. Mag. **149**: t.8982 (1924).

Type: S.W. Africa, Keetmanshoop, *Dinter* 2598 (SAM!).

The type is stated to be "Keetmanshoop and Aus"; there are two sheets of this number in SAM: one "cult. Okahandja" without locality of origin and the other "Keetmanshoop cult. Okahandja". It seems that this second specimen should be selected as the lectotype.

*Caralluma lutea* sensu Wordsworth, Hutchinson, F. & L. Bolus in Ann. Bolus Herb. **3**: 26 (1923).

*Caralluma nebrownii* var. *pseudonebrownii* (Dinter) White & Sloane, op. cit. **1**: 377 (1937).—Luckhoff, op. cit.: 66 (1952).—Jacob. tom. cit.: 252 (1960).

Type: As for *Caralluma pseudonebrownii* Dinter.

*Caralluma vaga* (N.E. Br.) White & Sloane, op. cit. **1**: 381 (1937).—Jacob., tom. cit.: 257 (1960).

Type: As for *Stapelia vaga* N.E. Br.

*Caralluma nebrownii* var. *discolor* Nel in White & Sloane, Stap. **1**: 380 et **3**: 1144 (1937).—Jacob., tom. cit.: 252 (1960).

Type: S.W. Africa, Tsamap, *Rusch* in Herb. Stellenbosch 7366 (STE!).

*Caralluma hahnii* Nel in White & Sloane, op. cit. **3**: 1164 (1937).—Jacob., tom. cit.: 246 (1960).

Type: S.W. Africa, Ovamboland, Ondonga (?Ondangua), No. 7364 in Herb. Stellenbosch (STE†).



*Leach & Cannell 14039 B.*

Plant from near Cahama, Huila Distr., S. Angola, flowering at PRE, flowers blackish maroon.

*Photo by kind permission of Chief, Botanical Research Institute, Pretoria*



*Leach & Cannell 14039C*

Plant from near Cahama; flowers maroon with pale pinkish flecks.



*Leach & Bayliss 13052*

Plant from near Ondangua, Ovamboland with reddish maroon flowers with minute yellow dots.

*Photos L. C. Leach*

FIG. 5. *Caralluma lutea* N.E. Br. subsp. *vaga* (N.E. Br.) Leach

The type material has not been traced and is assumed to have been lost or destroyed. The description and figure in White & Sloane (*l.c.*) does not, however, appear to differ from that of subsp. *vaga* which is known to be plentiful around Ondangua, moreover no other taxa belonging in this group are known to occur in Ovamboland; *C. hahnii* has therefore been placed in synonymy.

Subsp. *vaga* is distinguished by its proportionally much broader corolla lobes which are normally about 1·5 to 2·5 times as long as broad. As previously



Plowes 1943

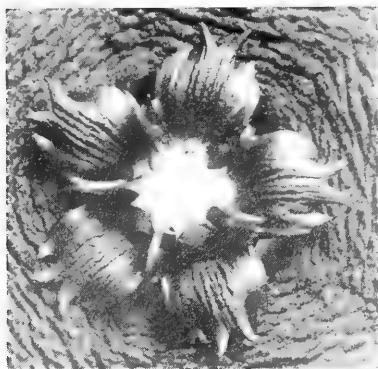
Lucydale Farm, Matopos, Rhodesia.



Plowes 1529

Nyamandhlovu, Rhodesia.

Showing extremes of variation in corona lobes of *Caralluma lutea* N.E. Br. subsp. *lutea*.



Leach & Bayliss 13034B

FIG. 6. *Caralluma lutea* N.E. Br. subsp. *vaga* (N.E. Br.) Leach.

Ondangua, Ovamboland. Shewin extreme form of corona which is, however, quite comparable with Plowes 1529 above.

Photos by courtesy of Mr. D. C. H. Plowes

mentioned, a few specimens from the S.W. African intermediate forms fall within the range of ratios (corolla length/width) of subsp. *lutea*, but these are considered to lend support to rather than to upset the taxonomic conclusions now reached.

ANGOLA. Huila District,  $\pm$  4 mls. SE of Cahama, cult. Nelspruit, *L. & C. 14039A* (M; S; SRGH; WIND), *14039B* (K; LUA; LUAI; PRE), *14039C* (BM; LISC); Seedlings from seed gathered  $\pm$  4 mls. SE of Cahama, cult. SRGH, 1969, *14039Aa* (BOL; BR; COI; KIEL; FI; MO; ZSS), *14039Ba* (LISU), *14039Ca* (K; LISC; PRE; SRGH).

S.W. AFRICA. 1715 (Ondangwa), Ondangwa (-DD), 5.ii.1959, *De Winter & Giess 6880* (PRE; SRGH; WIND);  $\pm$  12 mls. N of Ondangwa (-DD), cult. Nelspruit, *L. & B. 13041B* (PRE), *13041C* (K; MO), *13041D* (BM; BOL; LISC; LUA; LUAI; M; SRGH; WIND);  $\pm$  5 mls. N of Ondangwa (-DD), cult. Nelspruit, *L. & B. 13035* (BR; G; M; NBG; LISJC; LMA; Z);  $\pm$  3 mls. N of Ondangwa (-DD), cult. Nelspruit, *L. & B. 13034A* (B; COI; FHO; FI; MAH; PUC), *13034B* (BM; GRA; LISU; STE; SRGH), idem cult. Umtali, in *Plowes* (SRGH), *13034C* (BOL), *13034D* (K; LUA; LUAI; PRE).

1716 (Enana), Olukonda (-CC), 15.i.1886, *Schinz 2047* (K; Z), ibid. fr. 14.x.1885, *Schinz 2042* (Z); ?1716 (Enana), Onkumbi, fr. ix.1885, *Schinz 2041* (Z).

1816 (Namutoni),  $\pm$  10 mls. SE of Ondangwa (-AA), cult. Nelspruit, *L. & B. 13032* (G; KIEL; LISC; LUA; LUAI; NBG; WIND); *L. & B. 13052* (MO; ZSS);  $\pm$  20 mls. SE of Ondangwa (-AA), cult. Nelspruit, *L. & B. 13054* (K; PRE; SRGH);  $\pm$  25 mls. SE of Ondangwa (-AB), cult. Nelspruit, *L. & B. 13031* (BM; BR; LISC; M; SRGH; WIND);  $\pm$  35 mls. SE of Ondangwa (-AD), cult. Nelspruit, *L. & B. 13029* (BOL; K; PRE); Etosha Pan, fr. vii.1899, *Dinter* s.n. (Z); ibid. cult. Umtali, 24.ii.1969, *Braine* in *Plowes* 2923 (SRGH).

2115 (Karibib), Omaruru (-BD), 2.iv.1936, *Triebner* s.n. (PRE); Farm Klein Spitzkop, SW70 (-CC), 23.iii.1965, *Giess & Hardy 8470* (WIND); between Grosse & Klein Spitzkop, (-CC), 27.iii.1965, *Hardy 2150* (PRE).

2216 (Otjimbingwe), Otjiswa (Otjisewa) (-BD), 16.iii.1899, *Dinter 2488* (Z); Khomas Hochland, Farm Friedenau (-DB), 22.iii.1955, *De Winter 2586* (PRE; WIND).

2217 (Windhoek), Windhoek (-CA), cult. NBG 699/31, i.1932, *Bosch* s.n. (BOL); ibid. 25.iii.1964, *Homann* in *Giess 7814* (WIND); Rehoboth N, Farm Bergland (-CC), cult. Windhoek, iv.1959, *Giess 1990* (WIND).

2218 (Gobabis), Gobabis (-DB), iii.1966, *Tölken 1079* (PRE).

2316 (Nauchas), Rehoboth W, Farm Isabis (-AD), cult. Windhoek, iv.1959, *Giess* s.n. (WIND); Nauchas (-CB), 3.i.1916, *Pearson 9499* (BOL; K).

2317 (Rehoboth), Rehoboth (-AC), *Triebner* s.n. (PRE).

2617 (Bethanie) Kuibis (-CA), cult. NBG 425/55, 5.iv.1957, *Hall* s.n. (NBG).

2618 (Keetmanshoop), Keetmanshoop (-CA), xii.1909, *Dinter* 2255 (SAM), cult. Okahandja, *Dinter* 2598 (SAM).

2717 (Chamaïtes), Inachab (-CA), fl. & fr. xi.1897, *Dinter* 1056 (Z); Gorges (-CB), cult. NBG 1997/16 et 2599/16, del. *Page* (BOL).

2718 (Grünau), Gründoorn (-AD), 4.ii.1909, *Pearson* 4350 (BOL; K) Klein Karas (-CA), cult. NBG 744/28, 14.iii.1929, *Hill* s.n. (BOL).

2819 (Ariamsvlei), Tsamap (AA), *Rusch* s.n. (STE).

Without precise locality: *Elwes* s.n., fig. in Bot. Mag. t.8982 (K); Hort. Hanbury, 1907 "from the type plant" (K). *Dinter* s.n. (?1502) "Type specimen" (K); Kalkfontein South (probably near Karasburg or possibly near Grootfontein), *Coppens* s.n. (PRE).

S. AFRICA. Cape, 2820 (Kakamas), Keimoes (-DB), *Strey* 3882 (PRE); Kakamas (-DC), cult. NBG 417/40, 6.v.1941, (NBG).

Although fruiting specimens only and therefore not certainly identifiable, *Schinz* 2041 and 2042 from Ovamboland and *Dinter* s.n., Etosha Pan, have been included on the evidence of their vegetative characteristics and the localities (the two former particularly as these were cited by Berger under *C. nebrownii* in his monograph of 1910).

Distribution of this subspecies appears to be restricted to S.W. Africa and some neighbouring areas of S. Africa in the vicinity of Kakamas and Upington just south of the Orange River, and to southern Angola in the southern portion of Huila District adjacent to Ovamboland, in which latter territory the most densely populated concentrations appear to occur.

Whether evolutionary development of the species has taken place along the "lutea-vaga" axis or whether the present situation results from a once more widespread distribution, with perhaps a more or less centrally situated origin of which the present extremely variable intermediate populations are relictual is open to question. It does appear to the writer however, in view of the overall similarity of coronal form, that hybridisation is unlikely to have been responsible.

## 2. *Caralluma albocastanea* (Marl.) Leach, comb. nov.

*Stapelia albocastanea* Marl. in Trans. Roy. Soc. S. Afr. **3**: 124 (1913).—*Dinter*, Neue Pfl. S.W. Afr.: 50, t.38 (1914).—F. & L. Bolus & R. Glover, Ann. Bolus Herb. **1**: 75 (1915).—*Dinter* in Feddes Rep. **23**: 365 (1927).—Marl. Fl. S. Afr. **3**, 1: 99, t.23F. (1932).—White & Sloane, Stap. **2**: 524 (1937).—Jacob., Handb. Succ. Pl. **2**: 850 (1960).—Huber in Prodr. Fl. S.W. Afr. **114**: 62 (1967).

Type: S.W. Africa, Maltahöhe, *Marloth 5110* (PRE!).

*Stapelia caroli-schmidtii* Dinter et Berger in Engl., Bot. Jb. **50**, Suppl.: 592 (1914).

Type: S.W. Africa, Bullspoor Flats, Karas Mountains, *Dinter 2105*.

In the shape and particularly in the granulate texture of its corolla, in the construction of its corona, especially of the inner lobes, and perhaps most significantly, in the shape of its pollinia, *C. albocastanea* appears clearly to belong in the "lutea group", and with *C. lutea* accepted in *Caralluma* the new combination becomes virtually obligatory.

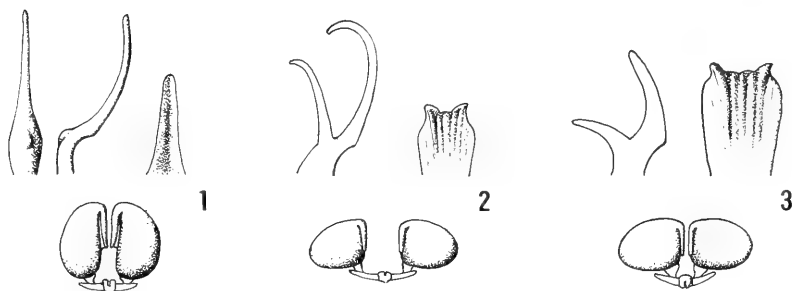


FIG. 7. Comparison of corona lobes and pollinia.

Corona lobes  $\times 5$  approx.

Pollinia  $\times 15$  approx.

1. *Stapelia jucunda* N.E. Br., *Haagner* s.n. Williston, Cape.
2. *Caralluma albocastanea* (Marl.) Leach, *Marloth 5001*, Maltahöhe.
3. *Caralluma knobelii* (Phillips) Phillips, *Bulawayo Mus.* s.n. Sekhuma Pan, SE Botswana.

In this connection it may be pertinent to note that although there has, in the past, been some uncertainty in respect of the generic placing of some members of the group, particularly e.g. of *C. melanantha*, there appears never to have been any doubt regarding that of *C. lutea* which has remained firmly and unquestioned, and it seems justifiably, in *Caralluma* since it was first described by N. E. Brown in 1891.

When describing his species Marloth related it to *Stapelia jucunda* N.E. Br. but this relationship does not appear to be very close; in particular, the corona form, pollinia shape and the texture of the corolla are all quite different (see fig.), the resemblance appearing to lie mainly in the marking and colouring of the corolla.

S.W. AFRICA: 2416 (Maltahöhe), near Maltahöhe, cult. Cape Town, fl. March 1912, *Marloth 5510* (PRE).

2718 (Grunau), Narudas Süd, Great Karasberg (-B), 7.i.1913, *Pearson 8471* (PRE).

Although *C. albocastanea* and *C. knobelii* are apparently very closely related it is considered that the discontinuities apparent, at least at our present level of knowledge of their distribution and variation, are sufficient to warrant the retention of specific status for these two taxa.

The habit of *C. albocastanea* with its spreading, tufted, above-ground growth form and more widely spaced succession of smaller flowers borne on much longer pedicels, appears to be quite different from that of *C. knobelii* which has developed a partially subterranean habit with underground stems giving rise to plantlets, often at some little distance from the parent plant, after the manner of *C. maculata* N.E. Br. The smaller flowers of *C. albocastanea* with proportionally narrower corolla lobes, usually about twice as long as broad, are borne on long pedicels, the shortest of which, according to the records, is longer than the longest (var. *langii*) seen or recorded for *C. knobelii*. The two horns of the inner corona lobes of *C. albocastanea* are not only generally longer than those of its relative but are more nearly equal in length, with the sub-erectly spreading outer horn usually almost as long as the inner, as opposed to the more subhorizontally spreading, shorter horn of *C. knobelii*. The outer corona lobes of the S.W. African species are also very much smaller than those of any other taxa belonging in this group.

A further distinction lies in the attachment of the pollinia to the carrier; when the pollinia are pressed flat while still attached to the carrier, they appear to be attached near the ends of the wings, so leaving a space ( $\pm 0.3$  mm) between the pollinia. This arrangement has not been noted in any of the closely related taxa and, within the limits of the admittedly limited material examined, appears to be constant for the species.

The ground colour of the corolla appears to be somewhat variable, being described as: white or creamy (Marloth), light grey (Pearson) and dull green (Jacobsen) while the markings are said to range from brown or dull red to almost blackish purple.

**3. *Caralluma knobelii*** (Phillips) Phillips in Flower. Pl. S. Afr. **15**: t.593 (1935). —White & Sloane, Stap. **1**: 366 (1937). —Luckhoff, Stap. S. Afr.: 64 (1952). —Story, Pl. Bushmen Food, S. Afr. Bot. Survey **30**: 42, t.47 (1958). —Jacob., Handb. Succ. Pl. **1**: 248 (1960). —Leistner, Pl. Ecol. S. Kalahari, S. Afr. Bot. Survey **38**: 57 etc. (1967).

Type: Botswana, *Knobel* s.n. No. 8308 in PRE (PRE!).

*Stapelia knobelii* Phillips, op. cit. **10**: 363 (1930).

Type: As for *Caralluma knobelii*.



*Caralluma langii* White & Sloane Stap. Ed. 1: 61 (1933).

Type: Botswana, Gaberones, *Van Son* s.n.

*Caralluma knobelii* var. *langii* (White & Sloane) White & Sloane, tom. cit.: 368 (1937).—Jacobsen, tom. cit.: 248 (1960).

Type: As for *Caralluma langii*.

*Caralluma kalaharica* Nel in White & Sloane, op. cit. 3: 1165 (1937).—Jacob., tom. cit.: 247 (1960).

Type: Botswana, Tsau (NW of Lake Ngami), *Nel* s.n. cult. *Triebner* 2105 (STE†).

Its smaller distinctively coloured flowers with proportionally much wider corolla lobes as well as its different habit immediately distinguish this species from the related *C. lutea* subsp. *lutea* with which it shares a portion of its distribution.

The corona of *C. knobelii* differs from those of all its near relatives in that the outer horn of the inner corona lobes is more widely, often more or less



FIG. 8. *Caralluma knobelii* (Phillips) Phillips.  
Typical flowers with striped outer corona lobes. Origin unknown.

*Photo. Herbert Lang, by courtesy of Chief, Botanical Research Institute, Pretoria*

horizontally spreading, as opposed to the more usual erect or suberect arrangement. Its nearest relationship however, appears to be with *C. albocastanea* and this is discussed under that species.

*C. kalaharica* Nel has been placed in synonymy, as although spatially distant from the assumed type locality of *C. knobelii* it appears to occur in the same general ecological and distributional area occupied by that species, while from the description (it is unfortunate that the type material appears to have been lost or destroyed) it does not seem to differ materially from typical *C. knobelii*. Furthermore, in view of the opinion of White & Sloane (*l.c.*) that morphologically it falls between the typical variety and var. *langii*, it seems quite illogical to accept it as being specifically distinct.

Var. *langii* is also considered to be synonymous as although apparently more distinct than Nel's species it seems to fall well within the range of variability accepted for the group and which appears to be equally wide within *C. knobelii* (e.g. *Leistner* 2215 with corolla lobes as narrow or narrower than those of var. *langii*, and *Leistner* 2080 with 4-6-angled stems).

BOTSWANA. SW. Ghanzi, 25.vii.1955, *Story* 5090 (PRE); between Kuke Pan and Kika Pan, xi.1956, *Story* 4914 (PRE); Tsabong, *De Winter* 7481 (PRE).

SE. 12·5 miles NW of Molepolole, 1.xii.1954, *Codd* 8921 (PRE); Sekhuma Pan, cult. Bulawayo Mus. (SRGH).

S. AFRICA. Cape: 2622 (Tsabong), Kuruman Riv., *Leistner* 2215 (PRE).

2721 (Tellery Pan), Kuruman Riv., 14 miles W of Gordonia/Kuruman border (-AB), 8.xi.1961, *Leistner* 2226 (PRE).

2722 (Olifantshoek), Lang Pan (-CA), 9.xii.1960, *Leistner* 2080 (K; PRE).

*C. knobelii* appears to be restricted to calcareous sandy soils of the Kalahari and is of rather rare occurrence; its rarity being contributed to, in all probability, by the fact that it is eaten by both humans and animals (as commented upon by both *Story l.c.* and *Leistner l.c.*). This appears to be in marked contrast to the closely related *C. lutea* of which large numbers of plants of both subspecies have been seen by the author in the vicinity of African villages in the south-eastern parts of Botswana and particularly in Ovamboland where plants in open situations on otherwise bare soil were often clearly visible for some distance. Whether or not this is due to a difference in palatability is not known.

**4. *Caralluma melanantha* (Schlecht.) N.E. Br. in Fl. Cap. 4,1: 885 (1909).—**White & Sloane, *Stap.* 1: 354 (1937).—Gomes e Sousa in *Moçambique* 49: 65 (1947).—Luckhoff, *Stap. S. Afr.*: 33 etc. (1952).—Jacobsen, *Handb. Succ. Pl.* 1: 251 (1960).

Type: Transvaal, stony flats near Sandloop, *Schlechter 4694*.

*Stapelia* sp. Schlechter in Engl., Bot. Jb. **20**: 56 (1895).

*Stapelia melanantha* Schlechter, op. cit. **38**: 50 (1905).—Berger, Stap. ü. Klein.: 316 (1910).

Type: As for *Caralluma melanantha*.

*Stapelia furcata* N.E. Br. tom. cit.: 973 (1909).—Berger, op. cit.: 301 (1910).

Type: Transvaal, *Todd* s.n. (K!).

*Caralluma leendertziae* N.E. Br. in Ann. Transv. Mus. **2**: 47 (1909).—Phillips in Flower. Pl. S. Afr. **6**: t.224 (1926).

Type: Transvaal, Potgietersrust, *Leendertz 1279* (K!).

*Caralluma rubiginosa* Werdermann, Fedde. Rep. **30**: 54 (1932).—As “*f. rubiginosa*” White & Sloane, tom. cit.: 359 (1937).

Type: Hort. Berlin-Dahlem.

*Caralluma australis* Nel in White & Sloane, op. cit. **3**: 1153 (1937).

Type: Transvaal, Pietersburg Distr. *Kirsten* s.n., Hort. STE, No. 5881 (STE!).

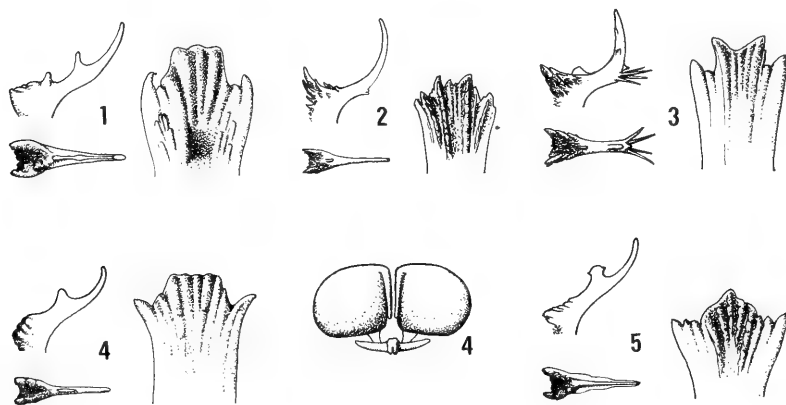


FIG. 9. *Caralluma melanantha* (Schlecht.) N.E. Br.

Corona lobes  $\times 5$  approx.

Pollinia  $\times 15$  approx.

1. *Leach 9756*, Smits Drift, Boyne, N. Transvaal.

2. *Leach 12261*  $\pm 10$  mls. N. of Moamba, Lourenço Marques Distr., Moçambique.

3. Operation Wild Fl. in *Leach 13283* Roossenekal, E. Transvaal.

4. *Leach 9757*, Bandalier Kop, N. Transvaal—showing typically subquadrate pollinia.

5. *STE 5881* Witputs, N. Transvaal—Type of *C. australis* Nel.

*Caralluma melanantha* var. *sousae* Gomes e Sousa in Moçambique **4**: 46 (1935).—White & Sloane, op. cit. **1**: 357 (1937).—Jacob. tom. cit.: 251 (1960).

Type: Moçambique, Lourenço Marques Distr., Mangulane.

*Caralluma melanantha* is an exceedingly variable species, particularly in respect of the inner lobes of the corona; no two specimens examined have been identical in coronal characters, while colouration, hairiness and flower size are almost equally variable. The species is, nevertheless, almost always immediately recognisable; it is, incidentally, one of the few species in the genus which may, with reasonable certainty, be identified from its stems.

The type material of *C. australis* Nel appears to fall well within the range of variation discussed above and is accordingly placed in synonymy, as also is var. *sousae* which appears to be merely another of the many individual variants,

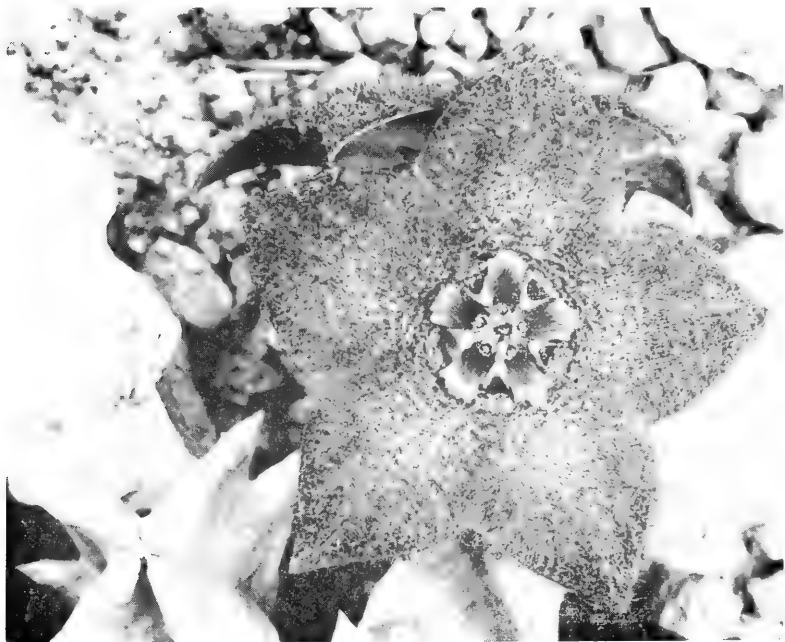


FIG. 10. *Caralluma melanantha* (Schlecht.) N.E. Br.

Corona with typical inner lobes deeply excavated at the base; corolla densely hairy. Origin unknown, cult. Transvaal Museum.

Photo. Herbert Lang, by courtesy of Chief, Botanical Research Institute, Pretoria

inasmuch as another specimen from the same area differs from the variety to as great an extent as it does from individual specimens from the Transvaal.

**MOÇAMBIQUE.** SS: Between Mapinhane and Mavume, March 1936, *A. Gomes e Sousa* s.n. (Photo. SRGH).

**LM:** Lourenço Marques Distr., cult. PRE, 4.iii.1963, *I.I.C.M. 13* (PRE); between Marracuene and Boane, 17.iii.1945, *E. de Sousa 79* (LISC; PRE); ± 10 mls. N of Moamba, cult. Nelspruit, *Leach 12261* (BM; BOL; BR; K; LISC; LMA; M; NBG; PRE; SRGH).

**SOUTH AFRICA.** Transvaal: ?2327 (Ellisras), Rhenosterhoek, Waterberg Distr. (-DD), cult. PRE 10196, ii.1952, photo., *Van Vuuren* s.n. (PRE).

2328 (Baltimore), Blauwberg (-BB), cult. PRE, ii.1955, *Codd 8777* (K; PRE); Mohlakeng Plateau, Blauwberg (-BB), 13.i.1955, *Codd & Dyer 9110* (PRE); Kwarriehoek (-CD), *Steyn 50* (PRE), *Steyn 80* (PRE).

2329 (Pietersburg), Van Wyksput (-AC), cult. STE, iii.1936, *Kirsten* in STE, (M) 662 (STE); Louis Trichardt (-BA), 18.ii.1960, *Schlieben & Streyl 8365* (PRE); Bandolierkop (-BC), cult. Greendale, 3.ii.1960, *Leach 9757* (K; KIEL; LMA; PRE; SRGH); Pietersburg Town Lands (-CD), iii.1935, *Kirsten 2* (PRE); Munnik (-DB), cult. PRE, i.1937, *Coaton & Hattingh* s.n. (PRE); 6 mls. E of Pietersburg (-DC), cult. Turfloop, 22.ii.1964, *Van Vuuren 1652* (PRE); 24 mls. E of Pietersburg, Smits Drift (-DD), 4.i.1948, *Bruce & Kies 53* (PRE); ibid. (-DD), 6.ii.1960, *Leach 9756* (G; SRGH); Boyne (-DD), cult. Umtali, 18.ii.1969, *Plowes 2634* (SRGH); Pietersburg Distr., iii.1935, *Kirsten 4* (PRE); Pietersburg, cult. PRE, iii.1919, *Munro* s.n. in Herb. Transv. Mus. 19732 (PRE).

2330 (Tzaneen), Ephrata near Elim (-AA), *Obermeyer* in Herb. Transv. Mus. 30617 (PRE); between Mokeetsi and Ellerton Mine, Duivelskloof, 26.viii.1945, *Graham* s.n. (PRE).

2427 (Thabazimbi), Hoopdal (-AD), 3.iii.1948, *Codd 3722* (PRE).

2428 (Nylstroom); Potgietersrust, "in the bush", ix.1908, *Leendertz 1279* (K), idem, cult. PRE, iii.1911 (K).

2429 (Zebediela), Pyramid Estate (-AA), 1.iii.1921, *Galpin 9030* (PRE); near Nebo (-DD), cult. Nelspruit, 14.ii.1964, *L. & B. 12083* (K; PRE; SRGH); Gompies Riv., Zebediela Estates, iii.1935, *Kirsten 3* (PRE); near Haenertsburg, 28.iii.1929, *Repton 6A* (PRE); Marabastad, cult. PRE, ii.1931, *Van Son* in Herb. Transv. Mus. 28273 (PRE).

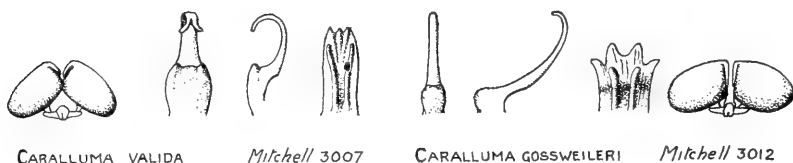
2528 (Pretoria), 2 mls. N of Hammanskraal (-AD), 4.i.1948, *Kies & Bruce 32* (PRE); Onderstepoort (-CA), 28.xii.1943, *Rossouw* s.n. (PRE); Derdepoot (-CB), 3.iv.1949, *Robertson 17* (PRE), ibid. 15.ix.1952, *Robertson 133* (PRE).

2529 (Witbank), Rossenekal, cult. Nelspruit, i.1968, Op. Wild. Flow. in *Leach 13283* (PRE); Selons Riv., cult. Johannesburg, 24.iii.1936, *Reynolds 769* (PRE).

Without precise locality: Sekukuniland, 11.iii.1935, *Barnard* 278 (PRE); "From the Transvaal" *Todd* s.n. comm. *J. M. Wood* (K), del. *Schweickerdt* (PRE).

The main distribution of this species is, according to the records, generally at rather higher altitudes (3,500 ft. to over 5,000 ft.) mainly in the Transvaal; the somewhat disjunct occurrence in southern Moçambique at low altitudes (well below 1,000 ft.) is therefore somewhat surprising. However, despite the altitudinal difference in habitat there seems to be no character or combination of characters on which these specimens can be separated from those from the Transvaal.

The occurrence of this species near Bulawayo, Rhodesia, as listed by White & Sloane (*l.c.*), appears almost certainly to be based on the misidentification of the dark flowered form of *C. lutea* subsp. *lutea* which is plentiful in the Matopos area and, it is thought, may well have originated in a tentative identification of an *Eyles* gathering from the Matopos.



Corona lobes  $\times 5$  approx. Pollinia  $\times 15$  approx.  
FIG. 11. A comparison of corona lobes and pollinia of *Caralluma valida* N.E. Br. and *Caralluma gossewileri* S. Moore.

**5. *Caralluma valida*** N.E. Br. in Kew Bull. **1895**: 264 (1895) et in Flora trop. Afr. **4**, 2: 486 (1902).—Berger, Stap. ü. Klein.: 89 (1910).—White & Sloane, Stapelieae **1**: 382 (1937).—Jacob., Handb. Succ. Pl. **1**: 257 (1960).—Leach in Jl S. Afr. Bot. **31**: 241 (1965).

Type: ?Botswana, *Holub* s.n. (K!).

S.W. AFRICA. Caprivi Strip, Mutsiku, 5 mls. E of Bagani, cult. Windhoek, 2.iii.1966, *Kohler* s.n. in *Giess* 9207 (WIND).

?BOTSWANA. Without locality, *Holub* s.n. (K).

ZAMBIA. B: Shangambo (Sivelewele), cult. PRE, 8.i.1953, *Codd* 7485 (PRE).

S: Mazabuka Distr., Siamambo For. Res., 27.xi.1960, *White* 7420 (FHO; SRGH); Livingstone Distr., Katambora For. Extn., cult. Livingstone, *Bainbridge* 1017 (FHO; NDO; PRE; SRGH), idem cult. SRGH (BM; BOL; K; LISC;

LUAI); Dambwa For. Res., cult. SRGH, iii.1966, *Mitchell 3007* (K; M; NDO; PRE; SRGH), idem cult. Nelspruit, 16.i.1968 (LISC; ZSS).

RHODESIA. N: Gokwe Distr. Charama Plateau, *Bingham 762* (SRGH), idem cult. Gokwe, *Bingham 762a* (SRGH).

W: Matobo Distr., cult. *Plowes 2454* (K; LISC); Lupane Distr., Bembesi Riv., cult. Greendale, xii.1960, *Leach 5811* (K; PRE; SRGH); ibid., ii.1965, *Walter 10* (SRGH), idem, cult. SRGH (K).

SOUTH AFRICA. ?Transvaal, ?Messina, cult. Messina, *Thompson s.n.* (PRE).

*C. valida* is gradually becoming better known and seems, although apparently closely related, to be specifically distinct from *C. huillensis* and *C. gossweileri* while being closest to *C. tsumebensis*, which species should possibly be considered to be separated only at varietal level; details of this relationship are discussed under the latter species.

From both the former *C. valida* may be readily distinguished by its smaller flowers and narrowly triangular (rather than narrowly ovate-attenuate or linear-attenuate), corolla lobes, while the pubescence (usually associated with short bristle-like hairs not known to occur in the related spp.) of the corolla inner surface is much coarser than that of either *C. huillensis* or *C. gossweileri*. The corona of *C. valida*, although very variable in the actual shapes of the lobes, is of a characteristically erect form (which is quite different from the more spreading habit of those of its congeners), which causes both the pollinia and the stigmatic cavity to be very inaccessible by comparison with those of any of the other taxa discussed (unfortunately such characters are usually destroyed when specimens are pressed). Finally the pollinia are a somewhat different shape and being attached to the carrier at about the mid-point of their inner margin are set at quite a different angle.

The distribution of *C. valida* to some extent overlaps that of *C. gossweileri* from which species it may additionally and most easily be recognised by the conspicuous ciliation of paper coloured vibratile hairs with which its corolla lobes are densely fringed.

**6. *Caralluma tsumebensis*** Oberm. in White & Sloane, *Stap.* 3: 1163 (1937).—Jacob., *Handb. Succ. Pl.* 1: 256 (1960).

Type: S.W. Africa, Tsumeb, *Nägelsbach s.n.* in Herb. Transv. Mus. 32820 (PRE!).

S.W. AFRICA. 1917 (Tsumeb), Tsumeb (-B), cult. Pretoria, *Nägelsbach s.n.* in Herb. Transv. Mus. 32820 (PRE).

1920 (Tsumkwe), Gautscha Pan (-DC), *Story 5312* (PRE).

Apart from the specimen from Gautscha Pan, somewhat doubtfully included here, *C. tsumebensis* is known only from the type locality, in fact it seems possible that all examples from Tsumeb may be from one cultivated clone.

A series of excellent detailed sketches by Mr. W. Giess (unfortunately space will not permit the reproduction of the whole series) depicts a plant flowering in Oct. 1943, in cultivation at Andalusia near Kimberley; this plant also was brought from a Tsumeb garden and may well be a portion of Dr. Nägelsbach's original plant. These drawings show slight variations in the coronas of different flowers from the one inflorescence. The inner corona lobes, which are usually more or less subhorizontally incumbent on the anthers, appear to be reminiscent of those of *C. huillensis* as are also the spreading outer lobes; however the somewhat stipitate corona is, as a whole, considered to be rather closer to that of *C. valida* as also is the relatively small corolla which is, however, quite devoid of the conspicuous ciliation of that species. The pollinia, according to Mr. Giess's sketches, appear to be close to those of *C. valida*, particularly in respect of the point of attachment to the carrier; however, this similarity is to some extent offset by their relative accessibility as compared with that of the deeply set pollinia of *C. valida*.

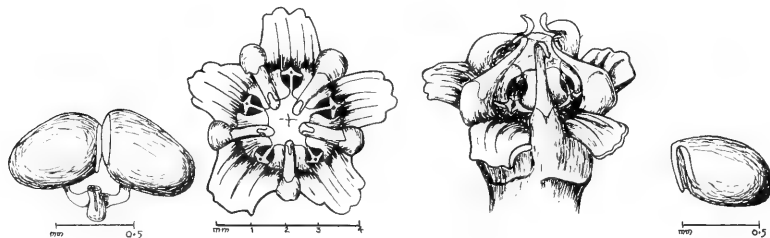


FIG. 12. *Caralluma tsumebensis* Oberm.

After pencil sketches by Mr. W. Giess, drawn from a plant from Tsumeb, S.W.A., flowering at Andalusia, N. Cape, S. Africa.

The stems of *C. tsumebensis* are stated to be 5-angled, but the pieces included in the type material give the impression of being 4-angled, as do those in a photograph by Dr. Nägelsbach, of a plant in cultivation at Tsumeb, as well as those depicted in Mr. Giess's sketch. A plant assumed to be this species (again obtained from a Tsumeb garden as recently as 1966) seen by the writer in cultivation in Mr. Giess's garden at Windhoek was also of the usual quadrangular pattern; unfortunately this plant died before flowering.

The red-flowered plant from Gautscha Pan, some 170 miles to the east of



Tsumeb, appears to be closest to *C. tsumebensis* despite its proportionally wider corolla lobes which are sparsely ciliate and has, therefore, been tentatively included here. In the photograph of this specimen the stems appear to be 5-angled.

It seems probable that both these specimens should be considered as being separable from *C. valida*, at most at varietal level, however, until authentic living, or at least, spirit material becomes available, the writer prefers to leave them under *C. tsumebensis*, especially in view of the element of doubt regarding the number of angles to the stems.

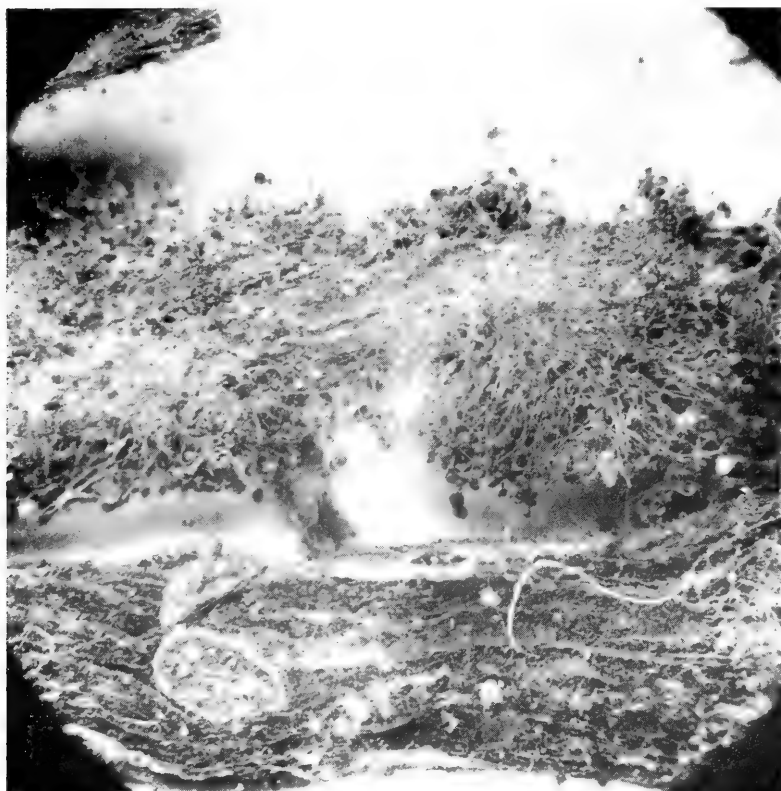


FIG. 13. *Mucor* sp. on stems of isotype material of *Caralluma huillensis* Hiern, Welwitsch 4266 (LISU).

*Photo by courtesy of Dr. G. C. A. van der Westhuizen*

7. *Caralluma huillensis* Hiern, Cat. Afr. Pl. Welw. 1: 697 (1898).— N.E. Br. in Flora trop. Afr. 4,2: 487 (1903).—Berger, Stap. ü. Klein.: 88 (1910).—White & Sloane, Stap. 1: 347 (1937).

Type: Angola, Huilla, *Welwitsch 4266* (BM; LISU!).

In Hiern's description it is stated that the stems are obsoletely pubescent, and this supposed character, so unusual in the genus, has served to set *C. huillensis* apart from its near relatives. However, examination of the LISU specimen disclosed that the stems are, in fact, glabrous, although bearing patches of fungal hyphae; it has also been confirmed by Mr. J. F. M. Cannon of the British Museum, that the holotype is similarly glabrous and is also, to a slight extent, attacked by a fungoid growth.

I am much indebted to Dr. G. C. A. van der Westhuizen of the Plant Protection Research Institute, Pretoria for the following information and the photograph accompanying this article: "The fungus on this specimen is a *Mucor* sp. The fungus is overmature and cannot be identified to the species".

*Caralluma torta* N.E. Br. is the only other species in the genus which is described as having pubescent stems. In view of its small *Ceropegia*-like flowers one wonders if this plant does, in fact, belong in *Caralluma* or whether it would perhaps be more comfortably accommodated in *Ceropegia*, in which genus stem pubescence is not uncommon, while the twisted lobes and even the markings of the corolla of *C. torta* are certainly closely paralleled in *Ceropegia*.

It was primarily this reported pubescence of the stems which caused the writer, when discussing *C. gossweileri*, to relate that species to *C. valida* rather than to *C. huillensis*. However, now that the stems of the latter are known to be glabrous it is apparent that *C. huillensis* and *C. gossweileri* are very closely related indeed and may eventually prove to be conspecific.

None of the descriptions of *C. huillensis* mentions cilia; however, the two subsequent gatherings from Huilla were found to possess clavate cilia and although none was observed in the LISU material a suspicion remained that *C. huillensis* might originally have been ciliate. Mr. Cannon, who has kindly examined the type specimen for this character also, has now confirmed that there are a few clavate cilia present as well as the short bristly remains of others, to be seen on one only of the flowers. From this it seems that *C. huillensis* is, in fact, ciliate, although it appears that the ciliation varies considerably in density and is possibly sometimes absent in individual flowers. These clavate vibratile hairs have often been recorded as readily caducous, consequently specimens from plants known to possess cilia may often appear to be without or to be only sparsely ciliate, dependent to some extent on age and the amount of handling to which the specimen has been subjected.

ANGOLA. Huila Distr., Humpata, 1800 m alt. *Gossweiler* 12612 (LISC); Huila, "arredores da Missão de Catolica," 10.xi.1955, *Santos* 119a (LISC); "Huilla" without precise locality, *Welwitsch* 4266 (LISU).

The distribution of *C. huillensis* as presently known appears to be restricted to the Planalto da Humpata at altitudes of 5,000 ft. or more and is associated with the Cunene River system, while the closely related *C. gossweileri* appears to enjoy a more widespread distribution associated with the Cubango-Cuando-Zambesi systems at somewhat lower altitudes.

**8. *Caralluma gossweileri*** S. Moore in J. Bot. Lond. **50**: 367 (1912).—Rendle, *Gossweiler's Angol. Pl.*: 100 (1934).—White & Sloane, *Stap.* **1**: 346 (1937).—Gossweiler & Mendonça, *Carta Fitogeogr. Angol.*: 162 (1939).—Leach in Jl S. Afr. Bot. **31**: 245 (1965).

Type: Angola, Vila Artur de Paiva, *Gossweiler* 2098 (BM; COI!; K!).

All gatherings of *C. gossweileri* known to the author are quite devoid of cilia, a character which in live, and usually also in dried, flowering material, enables it at once to be distinguished from its relatives. The inner lobes of the corona appear, in the material seen, to be more or less terete above whereas those of both *C. valida* and *C. huillensis* tend to be somewhat flattened and strap-like. However the total number of gatherings of these three species is small in relation to their distribution so that it is, at present, scarcely possible reliably to assess the full taxonomic significance of these and other characters; on present evidence however, it does seem that *C. valida* is specifically distinct, whatever may be the final decision in respect of *C. huillensis* and *C. gossweileri*.

ANGOLA. Huila Distr., Forte Princeza Amelia, Cubango Riv., *Gossweiler* 2098 (COI; K).

*Note*: Forte Princeza Amelia was a fortress near the present village of Vila Artur de Paiva (Vila de Ponte) on the left bank of the Cubango River [according to *Conspectus Florae Angolensis* this lies in the Bié District but a recent (1966) map places it in Huila District].

ZAMBIA. S: Livingstone Distr., Machili, 4.xii.1960, *Fanshawe* 5942 (SRGH); Kalumbu, cult. Ngoma, 14.x.1965, *Mitchell* 3012 (NDO), idem, cult. SRGH, i.1967, (K; SRGH), idem, cult. Nelspruit (BM; LISC; PRE).

RHODESIA. W. Nyamandhlovu Distr., Pasture Research Station, cult. *Plowes* 1884 (K; PRE; SRGH).



FIG. 14. *Caralluma gossweileri* S. Moore.  
Mitchell 3012 Plant from Kalumbu, Kafue National Park, Zambia, flowering at Nelspruit.  
Flowers blackish crimson, completely devoid of ciliation.

There is, unfortunately, not a great deal of cytological evidence available; all chromosome counts which have been made on members of the group indicate  $2n = 22$ , as follows:

*Caralluma lutea* subsp. *lutea*.

Yellow flowered, Baralong, S.E. Botswana, *Smithers* s.n. cult. SRGH 3719 (K; SRGH) (Reese, personal comm.)  $2n = 22$

Yellow flowered, Pietersburg, Transvaal, *Bey* 47 (SRGH) (Kelly, provisional count)  $2n = 22$

Dark flowered, origin unknown, (Reese ü. Kressel in Port. Act. Biol. Ser. A, 10: 48 (1967)).  $2n = 22$

*C. lutea* subsp. *vaga*.

Dark maroon flowered, Cahama, S. Angola, *Leach & Cannell* 14039 (K; KIEL; SRGH, etc.) (Reese, personal comm.)  $2n = 22$

*C. melanantha*, Pietersburg, Transvaal, *Bey* 45 (SRGH) (Kelly, provisional count)  $2n = 22$

*C. gossweileri*, Kalumbu, Livingstone Distr., Zambia *Mitchell* 3012 (NDO) (Reese, personal comm.).  $2n = 22$

However, if, as seems likely, judging by the other published records, there exists a pattern of polyploidy within the species, such as has been found in *Huernia hislopiae* Turrill, where diploids, triploids and tetraploids all occur within the typical subspecies (Reese 33 and 44 and Kelly 22), without, apparently, any significant morphological correlation, then it would seem to be unlikely that much assistance would be found in this direction.

#### ACKNOWLEDGEMENTS

The author is much indebted to and wishes to thank: Mr. & Mrs. R. D. A. Bayliss, Mr. N. D. Bey, Mr. & Mrs. E. J. Bullock, Mr. I. C. Cannell, Dr. G. Lamont and Mr. D. C. H. Plowes for much invaluable help in the field, for living plants from many localities, for spirit material and for many photographs.

Dr. L. E. Codd, Chief, Botanical Research Institute, Pretoria (PRE), for his personal interest and encouragement and for the facilities of the herbarium, and various members of his staff for much assistance in many directions, particularly Dr. R. A. Dyer for numerous taxonomic discussions and Miss M. Gunn and her assistants in the library for their patience in dealing with my numerous enquiries.

The Directors of the Department of Botany, British Museum (BM); the Bolus Herbarium, Cape Town (BOL); the Instituto Botânico Dr. Júlio Henriques, Coimbra, (COL); the Conservatoire Botanique Genève, (G); the Albany Museum, Grahamstown (GRA); the Moss Herbarium, Johannesburg (J); the Royal Botanic Gardens, Kew (K); the Centro de Botânica da Junta de Investigações do Ultramar, Lisbon (LISC); the Department of Botany, University of Lisboa (LISU); the National Botanic Gardens, Kirstenbosch (NBG); the Department of Botany, Stellenbosch University (STE); the Department of Agriculture, Windhoek (WIND) and the Botanical Institute of the University, Zürich (Z), for the loan of much valuable material and sundry other information in connection with this study.

Mr. R. B. Drummond, Chief Botanist, Government Herbarium, Salisbury (SRGH), for the facilities of the herbarium and much other assistance, and various members of his staff for their help in many ways, particularly Mr. R. Kelly for some chromosome counts of *Stapelieae*; also Mr. Th. Müller, Curator of the Botanic Gardens, and Mr. N. D. Bey of Highlands for their help in connection with cultivated plants when I was absent from Salisbury.

Mr. W. Giesse for the facilities of the herbarium and a great deal of help on those occasions when Windhoek was visited, and for permission to publish his sketches of *Caralluma tsumebensis*.

Prof. Dr. G. Reese, Botanisches Institut der Universität, Kiel (KIEL) for permission to publish some recent chromosome counts.



## FUNGUS SUCCESSION ON DUNG OF SOUTH AFRICAN OSTRICH AND ANGORA GOAT

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### ABSTRACT

Six fungi *Arthrobotrys dactyloides* Drechsler, *Ascobolus stictioideus* Speg., *Ascodesmis sphaerospora* Obrist, *Iodophanus carneus* (Pers. per Pers.) Korf, *Sordaria humana* (Fuckel) Winter and *Chaetomium species* are recorded in South Africa for the first time. Observations have been made on the fungus succession on dung of South African ostrich and Angora goat collected during September and November, 1969, from the same locality. Variations in the fungus flora are discussed.

### UITTREKSEL

**SWAM SUKSESSIE OP DIE MIS VAN DIE SUID-AFRIKAANSE VOLSTRUIS EN ANGORA BOK.** Ses swamme *Arthrobotrys dactyloides* Drechsler, *Ascobolus stictioideus* Speg., *Ascodesmis sphaerospora* Obrist., *Iodophanus carneus* (Pers. per Pers.) Korf, *Sordaria humana* (Fuckel) Winter en *Chaetomium species* is vir die eerste keer in Suid Afrika vermeld. Waarnemings is gedoen op die suksessie van Swamme op mis van Suid-Afrikaanse volstruis en Angora bokke versamel by dieselfde vindplek gedurende September en November, 1969. Variasies in die swamflora word bespreek.

### INTRODUCTION

It is well known that succession of fungus fruit bodies on herbivore dung is a very specialised one (Hudson, 1968). There appears to be an initial phase of phycomycetes mainly Mucorales, followed by discomycetes, then pyrenomycetes and ultimately basidiomycetes. It has been suggested that the spores of these coprophilous fungi are activated to germinate after a passage through the gut of an animal. This is most certainly true for species of *Pilobolus*, *Ascobolus* and *Sporormia*.

Although this succession is well known, detailed analyses have mainly been made on dung collected in countries from the northern hemisphere. Investigations have been made on rabbit dung (Harper & Webster, 1964) and faecal pellets of millipede, *Glomeris marginata* (Villiers) (Nicholson *et al.*, 1966).

Very little appears to have been published on fungus succession on dung collected in southern Africa. Gibbs (1909) investigated four samples of dung,

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Accepted for publication 12th May, 1970.

one being hippopotamus from Livingstone Island, Victoria Falls, the other three being samples from the Matoppos Hills. Gibbs recorded a complete absence of phycomycetes and there was a predominance of Sordariaceae, pyrenomycetes.

In this investigation a study was made of the colonization of dung of South African ostrich and Angora goat. This is the first time that fungi have been recorded on ostrich dung.

#### MATERIALS AND METHODS

South African ostrich and Angora goat were grazing in grassland enclosures at Groote Schuur Zoo, Rondebosch (CAPE—3318) and freshly deposited dung was collected on 26th September and 19th November, 1969. Ten samples of ostrich (5–10g) and ten pellets of Angora goat dung (0.3–0.6g) were each placed on sterile, moist filter paper in sterilized 14 cm Petri dishes and 10 cm crystallizing dishes respectively. The dishes were incubated at room temperature (17–21°C) in the light. The quantitative method of Harper & Webster (1964) for following fungus succession on dung was used.

#### NEW RECORDS

**Arthrobotrys dactyloides** Drechsler. Mycologia 29:447–552, 1937.

This species is recorded on nematode infested dung for the first time and frequency of the conidial structures on Angora goat dung are given in the histograms (Fig. 4). Previously it has been isolated from decaying leaves, roots of many plants and leaf mould. Drechsler (1937) describes this as “a strangling predacious fungus . . . bearing elongate uniseptate conidia in open capitate arrangement”. Vegetative mycelium and conidiophores are septate. Conidiophores bear a single cluster of 4–13 conidia. Conidia are elongate, ellipsoidal and slightly curved, being 32–48µm long and 7–9.5µm wide and there is no constriction at the septum.

**Ascobolus stictoides** Speg. Michelia 1:474, 1879.

Van Brummelen, 1967. *A world monograph of genera Ascobolus and Saccobolus (Ascomycetes, Pezizales)*. Leiden: Rijksherbarium.

The apothecia of this species are completely immersed in the substrata and are thus very difficult to find. The receptacle opens by irregular rupturing of the wall and asci protrude through the opening. The ascus wall stains deep blue in Melzer's reagent. The ascospores are at first hyaline but finally become dark violet in colour. Mature ascospores have the characteristic ornamentation consisting of coarse, rounded warts. Specimens were found growing on both ostrich and Angora goat dung.



**Ascodesmis sphaerospora** Obrist. Can. J. Bot. 39:943—953, 1961.

This species has been isolated from dung of dog, wild boar, jaguar and other carnivorous animals. These specimens were growing on ostrich dung. The genus is easily distinguished by its minute hemispherical apothecia without an excipulum. The apothecia consist of clusters of asci surrounded by paraphyses. The ascospores are spherical to ellipsoid with typical markings consisting of net-like, dark brown reticulations with ridges projecting about the periphery of the spores.

**Iodophanus carneus** (Pers. per Pers.) Korf apud Kimbrough & Korf. Am. J. Bot. 54:18, 1967.

This has been transferred from the genus *Ascophanus* to *Iodophanus* by Kimbrough & Korf (1967). Apothecia are convex, being about 1—2 mm diameter and orange coloured. The asci are unitunicate, operculate, cylindric to sub-cylindric and are slightly blued by Melzer's reagent. The ascospores are uniseriate, but the specimens recorded in this paper have consistently smaller ascospores being  $8.5\text{--}10.5\mu\text{m} \times 16.5\text{--}18.5\mu\text{m}$ .

Although cultural studies have already been performed by Gamundi & Ranalli (1964), multi-ascospored cultures were grown on potato dextrose agar and dung extract agar. They did not yield the typical *Oedocephalum* imperfect state.

From Europe and North America, it has been reported on various substrata, including dung, but these specimens were seen growing on ostrich dung only.

**Sordaria humana** (Fuckel) Winter Abhandl d. Naturf. Ges. Halle 13:24, 1873. C. Moreau, 1953. *Les genres Sordaria et Pleurage*. Paris: Encyclopédie Mycologique 25:330 pp.

This species is mainly found on human ordure (Ellis & Everhart, 1892), but it has been recorded on animal dung (Dennis 1960). Specimens were growing on Angora goat dung and a few perithecia were seen on ostrich dung. They fit the description of Dennis (1960) except that the ascospores appear to be smaller being  $11.4\text{--}13.0\mu\text{m} \times 17.1\text{--}21.4\mu\text{m}$ .

**Chaetomium** sp. nov.

The perithecia have unbranched terminal hairs and the ascospores are globose and weakly beaked. It agrees most closely with *Chaetomium bostrychodes* Zopf, but this is a variable species in which the hairs may or may not be branched. Cultures have been grown on dung extract agar and one has been deposited in the Commonwealth Mycological Institute collection (IMI 145973). Cultural characteristics and development of perithecia are being investigated and these will be described in a subsequent paper.

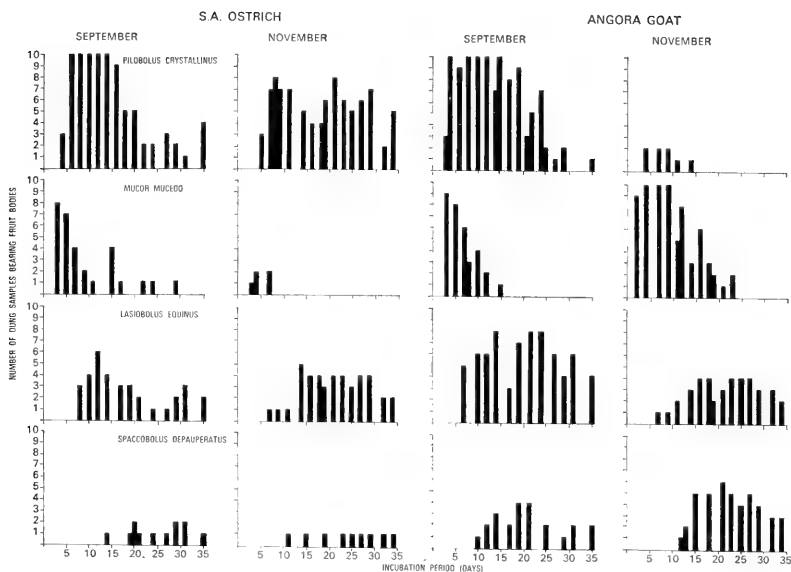


FIG. 1.

Frequency of fruiting of *Pilobolus crystallinus*, *Mucor mucedo*, *Lasiobolus equinus* and *Saccobolus depauperatus* on dung samples of S.A. ostrich and Angora goat collected during September and November, 1969.

#### DIRECT OBSERVATION ON COLONIZATION OF DUNG

The frequency of fruiting of phycomycetes, ascomycetes and basidiomycetes are expressed as histograms in Figs. 1—5. In the primary phase, *Mucor mucedo* (Linn.) Brefeld was the first to fruit after 2—3 days incubation and this was accompanied by sporangia of *Pilobolus crystallinus* Tode. In samples of ostrich dung collected during September and November, *P. crystallinus* persisted throughout the incubation period but although it was not possible to express this quantitatively, there was an observed decline in numbers of sporangia after 12 days incubation. In samples of Angora goat dung collected during September there was a considerable reduction in observed colonization by sporangia of *P. crystallinus* after 20 days incubation. Only two samples of Angora goat dung collected during November showed signs of colonization by *P. crystallinus*, but here, during the early stages of incubation all the samples were completely covered by mycelia and sporangia of *M. mucedo*.

Of the ascomycetes, apothecia of *Lasiobolus equinus* (Mull) Karst were the first to appear after 7 days incubation. Other discomycetes such as *Saccobolus*

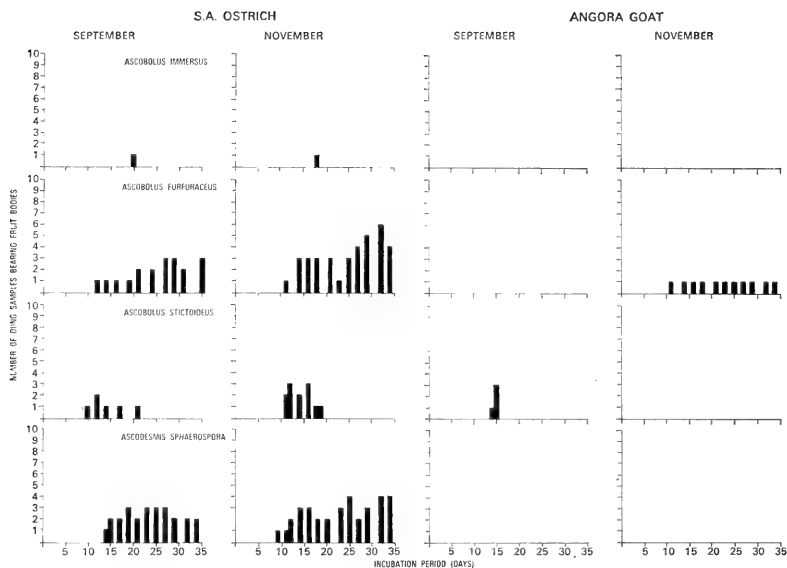


FIG. 2.

Frequency of fruiting of *Ascobolus immersus*, *Ascobolus furfuraceus*, *Ascobolus stictoides* and *Ascodesmis sphaerospora* on dung samples of S.A. ostrich and Angora goat collected during September and November, 1969.

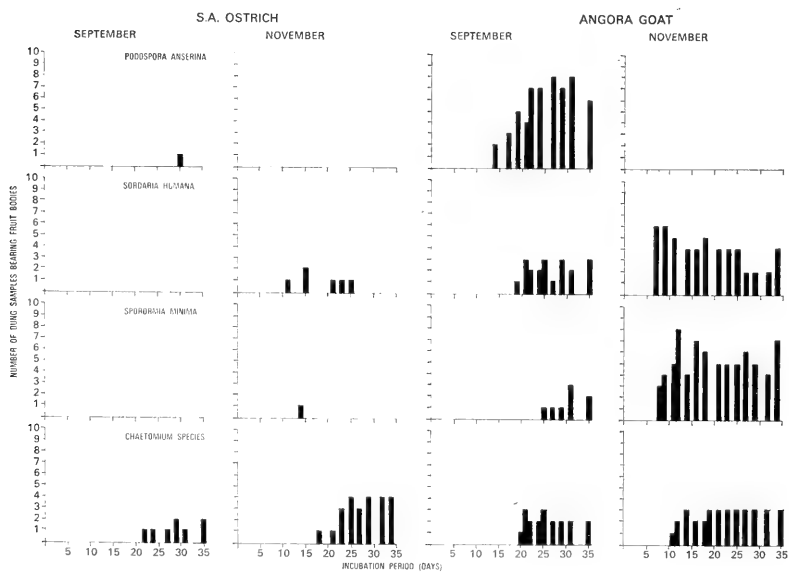


FIG. 3.

Frequency of fruiting of *Podospora anserina*, *Sordaria humana*, *Sporormia minima* and *Chaetoniium* species on dung samples of S.A. ostrich and Angora goat collected during September and November, 1969.

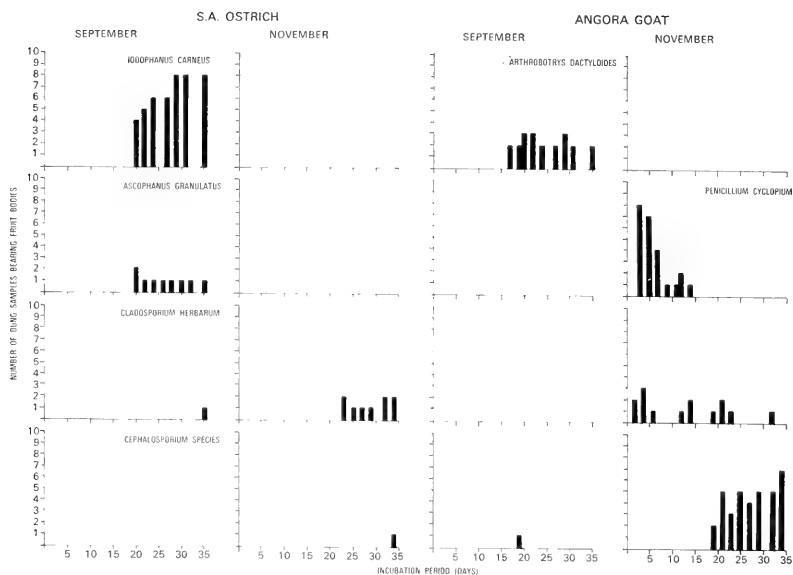


FIG. 4.

Frequency of fruiting of *Iodophanus carneus*, *Ascophanus granulatus*, *Cladosporium herbarum*, *Cephalosporium* species, *Arthrobotrys dactyloides* and *Penicillium cyclopium* on dung samples of S.A. ostrich and Angora goat collected during September and November, 1969.

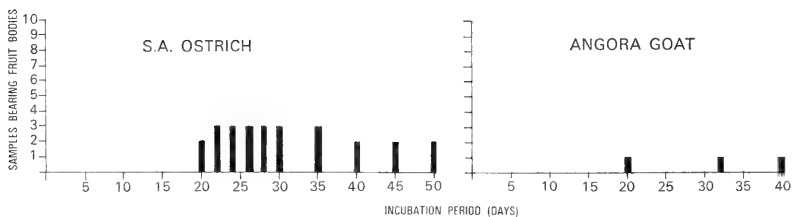


FIG. 5.

Frequency of fruiting of *Coprinus stercorearius* on dung samples of S.A. ostrich and Angora goat collected during September, 1969.

*depauperatus* (Berk & Broome) E. C. Hansen, *Ascobolus immersus* Pers. per Pers., *Ascobolus furfuraceus* Pers. per Hook, *Iodophanus carneus* and *Ascodesmis sphaerospora* were seen. Of these, *Saccobolus depauperatus* seemed to be the most frequent colonizing both ostrich and Angora goat dung. The other species were mainly isolated from ostrich dung but the November samples showed a general reduction in apothecial development with a complete absence of apothecia of *I. carneus*. There was, however, very little colonization by coprophilous pyrenomycetes on ostrich dung. *Podospora anserina* (Cesati) Niessl., *Sordaria humana*, *Sporormia minima* Auerswald and a *Chaetomium* species were identified on Angora goat dung. Time of sporulation varied but *Chaetomium* sp. was last to produce perithecia.

One basidiomycete was recorded. This was *Coprinus stercorearius* (Scop. ex Fr.) Fr. which fruited late in the fungus succession after 20 days incubation in those samples collected during September. The infrequency of basidiomycetes may account for the persistence of the phycomycete phase and ascomycete fruit bodies in many of the samples (Harper & Webster, 1964).

Times of sporulation of *Cladosporium herbarum* Link and *Cephalosporium* species are recorded in the histograms (Fig. 4). *Penicillium cyclopium* Westling has been isolated in the S.W. Cape (Doidge, 1945) but it is recorded on dung for the first time and is most likely an aerial contaminant.

## DISCUSSION

In general, the observations on dung samples confirm the well known succession of fruit bodies. The initial phycomycete phase was recorded which appears to contradict earlier observations on samples collected in southern Africa (Gibbs, 1909). The succession was observed within 35 days incubation but it has been stressed that this phenomenon is slower under field conditions than in the laboratory (Harper & Webster, 1964). However, samples were collected on two occasions, the first during a relatively moist month (September, 1969) and the other during a dry month (November, 1969). In the laboratory under optimum conditions, there was an observed reduction of fruit bodies including a complete absence of the basidiomycete phase in those samples collected during November. A majority of the November samples were colonized by *C. herbarum* and *Cephalosporium* species.

On ostrich dung there was a predominance of discomycetes whereas on Angora goat dung the coprophilous pyrenomycetes were more important. This variation poses an ecological question on the growth of these fungi. Further investigations will have to be carried out, but one possibility is proposed. It may be nutritional in that the fungi are growing on two substrates of different composition.

## ACKNOWLEDGEMENTS

I am very grateful to the Directors of the Royal Botanical Gardens and Commonwealth Mycological Institute, Kew, for examining and commenting on *Iodophanus carneus* and *Chaetomium species* respectively.

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## KLIPVELD STUDIES: I. CHECK LIST OF THE VEGETATION

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### ABSTRACT

The dolomite region which is flat and rugged and practically treeless, supports a rich herbaceous vegetation which is unique in several ways, such as the total absence of dominants. In spite of its importance generally and to farming in particular, our knowledge concerning its ecology is far from adequate. After the farm "Somerville", situated in the dolomite area, had been made available for research, the staff of the Botany Department of the Potchefstroom University for C.H.E. launched a long term project, covering various ecological aspects. The series of publications envisaged, is preceded by this check list.

### UITTREKSEL

Die plantegroei van die ruwe, feitlik boomlose dolomietvlaktes word gekenmerk deur 'n ryke verskeidenheid kruidagtige spesies en 'n totale afwesigheid van dominante. Ten spyte van die belangrikheid van die streek in die algemeen en vir boerdery in besonder, is ons kennis van sy ekologie nog geheel en al ontoereikend. Nadat die plaas „Somerville" wat tipies vir die streek is vir navorsing beskikbaar gestel is, het die personeel van die Plantkundedepartement van die Potchefstroomse Universiteit vir C.H.O. 'n langtermyn projek onderneem wat verskillende ekologiese aspekte behels. Die reeks artikels wat beoog word, word deur hierdie kontrolelys ingelei.

### INTRODUCTORY NOTE

This paper is presented as an introduction to a series of reports on various ecological projects—under way and to be undertaken—by the staff and post-graduate students of the Department of Botany of the Potchefstroom University for C.H.E. The first of these, which ran concurrently with the floristic survey, will be completed shortly.

The research is being conducted on the University farm "Somerville" No. 53, 2729 hectares in extent and situated in the Ventersdorp District in typical dolomite country, or "Klipveld". Although the dolomite region in the Transvaal covers some 1 442 630 hectares\* or 5·08 per cent\* of the total area of the province, and in spite of its importance to farming by virtue of its proximity to the main markets and a well-developed transport system, surprisingly little research has been done regarding veld productivity, plant succes-

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\* Figures kindly supplied by the Hydrology Section, Department of Water Affairs.  
Accepted for publication 5th May, 1970.

sion, responses of the vegetation to various external influences and similar problems. Considering the fact that in the Transvaal this veld type carries large numbers of cattle, generally of good quality, and to a lesser extent also sheep, it is evident that answers to these questions can have an important bearing on farming practice and future land values.

Dolomite country can be described as a vast, undulating, grass-covered plain of which the terrain is stony and rugged, especially on the slopes and rises, owing to the exposure of dolomite and chert. It supports a rich flora in which a large number of species, genera and families are represented. Perhaps the most remarkable feature of the vegetation is that any tendency towards dominance by any one species, seems to be entirely lacking. Each hectare of veld is constituted of a medley of individuals with wide and diverse affinities, yet floristically not much different from any other hectare. The grasses as a group are dominant, but the species are scattered and mixed throughout. In the seasonal succession, some grass species may appear to assume temporary local dominance, but this is purely physiognomical.

On the farm in question, two major features, viz. a sinkhole (a frequent phenomenon in the dolomite area) and a shallow depression or "pan" occur, each representing a set of ecological conditions different from those prevailing in the surrounding area. The sinkhole, which is shaded, cool and relatively moist owing to reduced evaporation, harbours a number of species peculiar only to such habitats. The "pan" held water for some months during the wet summer of 1967-68 and during that brief period accounted for a number of aquatics not seen since the survey was begun.

The survey covers the period 1962-68—a period marked by a prolonged and intense drought, broken only by the summer rains of 1967. During this wet season a considerable number of species were found or seen in flower, which in preceding years were not encountered. This might warrant the assumption that, had the survey been made during a moderately wet cycle, this check list would have been more complete. Herbarium specimens collected in the course of the survey are deposited in the University Herbarium.

#### ACKNOWLEDGEMENTS

I wish to record my sincere thanks to the Department of Agricultural Technical Services for a grant to defray subsistence and travelling expenses in connection with the present survey. To Dr. L. E. Codd, Director of the Botanical Research Institute, and his staff I owe a special debt of gratitude for facilities received and the hospitality enjoyed during my frequent—and often prolonged—visits to the National Herbarium, Pretoria, and particularly for the identification of my specimens.



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## CHECK LIST

## PTERIDOPHYTA

*Polypodiaceae (sens. lat.)*

- Asplenium aethiopicum* (Burm.) Becherer  
*Ceterach cordatum* Desv.  
*Pellaea calomelanos* (Sw.) Link  
*Pteridium aequilinum* (L.) Kuhn

*Marsileaceae*

- Marsilea* (prob.) *M. macrocarpa* (DC.) Presl.

## SPERMATOPHYTES

## MONOCOTYLEDONS

*Gramineae*

- Trachypogon spicatus* (L.f.) Kuntze  
*Elionurus argenteus* Nees  
*Andropogon amplexans* Nees  
*schirensis* Hochst. var. *angustifolia* Stapf  
*Schizachyrium semiberbe* Nees  
*Cymbopogon excavatus* (Hochst.) Stapf  
*plurinodes* Stapf ex Burt Davy  
*Monocymbium cerealiiforme* Stapf  
*Heteropogon contortus* (L.) Beauv.  
*Themeda triandra* Forsk.  
*Tragus berteronianus* Schult.  
*Alloteropsis semiliata* Hitchc. var. *ecklonii* Stapf  
*Panicum coloratum* L.  
*laevifolium* Hack.  
*natalense* Hochst.  
*Brachiaria nigropedata* (Munro) Stapf  
*serrata* (Spreng.) Stapf  
*Digitaria eriantha* Steud.  
*pentzii* Stent  
*smutsii* Stent  
*ternata* (Hochst.) Stapf  
*tricholaenoides* Stapf  
*Rhynchelytrum repens* (Willd.) C. E. Hubb.  
*setifolium* (Stapf) Chiov.  
*Setaria chevalieri* Stapf ex Stapf & Hubbard  
*flabellata* Stapf  
*verticillata* (L.) Beauv.  
*Ehrharta erecta* Lam.  
*Aristida canescens* Henr.  
*congesta* Roem. & Schult. ssp. *congesta*  
*diffusa* Trin. var. *burkei* (Stapf) Schweick.  
*Stipagrostis uniplumis* (Licht.) De Wint.  
 var. *neesii* (Trin. & Rupr.) De Wint.

- Sporobolus discosporus* Nees  
*festivus* Hochst. var. *fibrosus* Stapf  
*fimbriatus* Nees  
*pectinatus* Hack.  
*staphianus* Gand.  
*Tristachya rehmannii* Hack.  
*Loudetia simplex* (Nees) C. E. Hubb.  
*Cynodon dactylon* (L.) Pers.  
*hirsutus* Stent  
*Chloris virgata* Sw.  
*Eustachys paspaloides* (Vahl) L. & M.  
*Eleusine africana* Kennedy-O'Byrne  
*Enneapogon scoparius* Stapf  
*Triraphis andropogonoides* (Steud.) Phill.  
*Diplachne biflora* Hack.  
*Pogonarthria squarrosa* (Licht.) Pilg.  
*Trichoneura grandiglumis* (Rendle) Stapf & Hubb.  
*Eragrostis atherstonei* Stapf  
*barbinodis* Hack.  
*biflora* Hack.  
*chloromelas* Steud.  
*cilianensis* (All.) Lutati  
*curvula* (Schrud.) Nees  
*gummiflua* Nees  
*lehmanniana* Nees  
*obtusata* Munro ex Fic. & Hiern  
*plana* Nees  
*racemosa* (Thunb.) Steud.  
*superba* Peyr  
*Oropetium capense* Stapf

*Cyperaceae*

- Cyperus difformis* L.  
*esculentus* L.  
*margaritaceus* Vahl  
*rupestris* Kunth  
*usitatus* Burch.  
*Pycnus macranthus* C.B.C1.  
*Mariscus capensis* Schrad. var. *capensis*  
 var. *marlothii*  
*dregeanus* Kunth  
*Kyllinga alba* Nees  
*erecta* Schum.  
*pulchella* Kunth  
*Scirpus burkei* C.B.C1.  
*hystrix* Thunb.  
*praelongatus* Poir.  
*setaceus* L.

*Fimbristylis monostachya* Hassk.  
*Bulbostylis humilis* Kunth

#### *Commelinaceae*

*Commelina africana* L.  
*albescens* Hassk.  
*benghalensis* L.  
*subulata* Roth  
*Cyanotis speciosa* (L.f.) Hassk.

#### *Liliaceae*

*Bulbine stenophylla* Verdoorn  
*trichophylla* Bak.  
*Anthericum angulicaule* Bak.  
*cooperi* Bak.  
*Trachyandra laxa* (N.E.Br.) Oberm. var.  
*erratica* Oberm.  
*Eriospermum luteo-rubrum* Bak.  
*Aloe transvaalensis* O. Kuntze  
*Chortolirion angolensis* Bak.  
*Tulbaghia acutiloba* Harv.  
*Albuca pachychlamys* Bak.  
*Urginea sanguinea* Schinz  
*Dipcadi viride* Moench.  
*marlothii* Engl.  
*Scilla graminifolia* Bak.  
*nelsonii* Bak.  
*ovatifolia* Bak.  
*Eucomis clavata* Bak.  
*Ornithogalum virens* Lindl.  
*Asparagus africanus* Lam.  
*suaveolens* Burch.

#### *Amaryllidaceae*

*Boophane disticha* (L.f.) Herb.  
*Crinum graminicola* Verdoorn

#### *Hypoxidaceae*

*Hypoxis angustifolia* Lam.  
*nitida* Verdoorn  
*rigidula* Bak.

#### *Velloziaceae*

*Vellozia retinervis* Bak.

#### *Iridaceae*

*Tritonia nelsonii* Bak.  
*Babiana hypogaea* Burch.  
*Gladiolus edulis* Burch.  
*elliottii* Bak.  
*Lapeirousia grandiflora* Bak.

#### *Orchidaceae*

*Habenaria caffra* Schltr.  
*foliosa* Reichb. f.  
*Eulophia leontoglossa* Reichb. f.  
*ovalis* Lindl. ssp. *ovalis*

### DICOTYLEDONS

#### *Ulmaceae*

*Celtis africana* Burm. f.

#### *Urticaceae*

*Australina acuminata* Qedd.

#### *Santalaceae*

*Thesium transvaalensis* Schltr.  
*utile* A. W. Hill

#### *Polygonaceae*

*Polygonum plebeium* R.Br.  
*Oxygonum dregeanum* Meisn. var. *canescens*  
 (Sond.) R.Grah.

#### *Chenopodiaceae*

*Chenopodium album* L.  
*carinatum* R.Br.  
*Roubieva multifida* (L.) Moq.

#### *Amaranthaceae*

*Amaranthus hybridus* L.  
*thunbergii* Moq.  
*Cyphocarpa angustifolia* (Moq.) Lopr.  
*Achyranthes aspera* L.  
*Brayulinea densa* (H. & B.) Small  
*Alternanthera pungens* H.B.K.

#### *Phytolaccaceae*

*Limeum viscosum* (Gay) Engl. ssp. *viscosum*  
 var. *glomeratum* (Eckl. & Zeyh.)  
 Friedr.  
*Phytolacca octandra* L.

#### *Aizoaceae*

*Delosperma*, cf. *D. herbeum* N.E.Br.  
*Hereroa glenensis* N.E.Br.

#### *Portulacaceae*

*Anacampseros subnuda* Von Poellnitz  
*Portulacca oleracea* L.  
*quadrifida* L.

#### *Caryophyllaceae*

*Pollichia campestris* Ait.  
*Silene burchellii* Oth.  
*Dianthus mooiensis* Williams var. *kirkii*  
 (Burt. Davy) Hooper  
*mooiensis* ssp. *mooiensis* var. *mooiensis*

#### *Ranunculaceae*

*Clematis brachiata* Thunb.  
*Clematopsis scabiosifolia* (DC.) Hutch.

*Menispermaceae*

*Antizoma angustifolia* (Burch.) Miers ex Harv.

*Cruciferae*

*Lepidium africanum* (Burm.) DC.  
transvaalense Marais  
*Erucastrum strigosum* (Thunb.) Schulz  
*Brassica pachypoda* Thel.

*Capparidaceae*

*Cleome monophylla* L.  
rubella Burch.

*Resedaceae*

*Oligomeris dregeana* Presl.

*Crassulaceae*

*Kalanchoe rotundifolia* Harv.  
*Crassula nodulosa* Schönl.  
transvaalensis (O. Kuntze) K. Schum.

*Saxifragaceae*

*Vahlia capensis* Thunb.

*Rosaceae*

*Parinari capense* Harv.

*Leguminosae*

*Elephantorrhiza elephantina* (Burch.) Skeels  
*Bauhinia esculenta* Burch.  
*Cassia mimosoides* L.  
*Pleiospora cajanifolia* Harv.  
*Lotononis bracteata* Benth.  
calycina Benth.  
*Dichilus strictus* E. Mey.  
*Crotalaria sphaerocarpa* Perr. ex DC.  
*Indigofera burkeana* Benth.  
filipes Benth.  
hilaris Eckl. & Zeyh.  
pretoriana Harms  
rhytidocarpa Benth.  
*Tephrosia longipes* Meissn. var. *lurida* (Sond.) Gillett  
lupinifolia DC.  
polystachyoides Bak. f.  
*Ophrestia retusa* H. M. Forbes  
*Zornia linearis* E. Mey.  
*Erythrina zeyheri* Harv.  
*Rhynchosia nervosa* Benth.  
totta (Thunb.) DC.  
*Eriosema burkei* Benth.  
cordatum E. Mey. var. *gueinzii* Harv.  
*Vigna stenophylla* Burtt Davy  
*Sphenostylis angustifolia* Sond.  
*Dolichos angustifolius* Eckl. & Zeyh.

*Geraniaceae*

*Monsonia burkeana* Planch.  
*Pelargonium luridum* (Andr.) Sweet

*Oxalidaceae*

*Oxalis obliquifolia* Steud. ex Rich.

*Zygophyllaceae*

*Tribulus terrestris* L.

*Rutaceae*

*Fagara capensis* Thunb.

*Polygalaceae*

*Polygala amatymbica* Eckl. & Zeyh.  
hottentotta Presl.  
rehmannii Chod.

*Euphorbiaceae*

*Phyllanthus parvulus* Sond.  
*Acalypha angustata* Sond. var. *glabra* Sond.  
caperonioides Baill.  
*Euphorbia inaequilatera* Sond.  
rhombifolia Boiss.

*Anacardiaceae*

*Ozoroa paniculosa* (R. & A.) Fernandes  
*Rhus eckloniana* Sond.  
magalis-montana Sond.  
pyroides Burch.

*Celastraceae*

*Maytenus polyacanthus* (Sond.) Marais

*Rhamnaceae*

*Ziziphus zeyherana* Sond.

*Tiliaceae*

*Corchorus asplenifolius* Burch.  
*Grewia flava* DC.

*Malvaceae*

*Sida chrysantha* Ulbr.  
dregei Burtt Davy  
*Pavonia patens* (Andr.) Chiov.  
*Hibiscus calyphyllus* Cav.  
microcarpus Garcke  
trionum L.

*Sterculiaceae*

*Hermannia betonicifolia* Eckl. & Zeyh.  
depressa N.E.Br.  
lancifolia Szysz

*Guttiferae*

*Hypericum aethiopicum* Thunb. ssp. *sonderi* (Bredell) Robson

*Flacourtiaceae*

*Kiggelaria africana* L.

*Thymelaeaceae*

*Lasiosiphon canoargenteus* C.H.Wr. *capitatus* (L.f.) Burtt Davy *kraussianus* Meisn. *Arthrosolen sericocephalus* Meisn.

*Lythraceae*

*Ammannia baccifera* L.

*Umbelliferae*

*Heteromorpha trifoliata* (Wendl. & Bartz) Eckl. & Zeyh.

*Ebenaceae*

*Diospyros austro-africana* De Wint. var. *microphylla* (Burch.) De Wint. *lycioides* Desf. ssp. *guerkei* (Ktze.) De Wint. *lycioides* Desf. ssp. *lyciodes* De Wint.

*Oleaceae*

*Olea africana* Mill. *Menodora africana* Hook.

*Gentianaceae*

*Sebaea exigua* (Oliv.) Schinz *grandis* (E.Mey.) Steud.

*Asclepiadaceae*

*Raphionacme burkei* N.E.Br. *hirsuta* (DC.) R. A. Dyer *Xysmalobium brownianum* S. Moore *undulatum* R.Br. *Schizoglossum biflorum* Schltr. *glabrescens* Schltr. *Pachycarpus rigidus* E. Mey *schinzianus* N.E.Br. *Asclepias affinis* Schltr. *eminens* Schltr. *fruticosa* L. *glaucophylla* Schltr. *Pentarrhinum insipidum* E. Mey. *Orphanthera jasminiflora* N.E.Br. ex Schinz *Macropetalum burchellii* Decne. *Brachystelma foetidum* Schltr. *Caralluma lutea* N.E.Br.

*Convolvulaceae*

*Ipomoea bathycolpos* Hall.f. var. *bathycolpos* *graciliseipala* Rendle *obscura* Ker. var. *fragilis* (Choisy) Meeuse *ommanneyi* Rendle *Merremia verecunda* Rendle *Turbina oblongata* (E. Mey. ex Choisy) Meeuse

*Borraginaceae*

*Ehretia rigida* (Thunb.) Druce *Lithospermum cinereum* DC.

*Verbenaceae*

*Lantana rugosa* Thunb. *Chascanum adenostachyum* (Schauer) Moldenke *pinnatifidum* (L.f.) E. Mey. *Priva meyeri* Jaub. & Spach *Clerodendrum triphyllum* (Harv.) Pears.

*Labiatae*

*Teucrium capense* Thunb. *Stachys rugosa* Ait. var. *linearis* Skan *Salvia radula* Benth. *stenophylla* Burch. *Becium angustifolium* N.E.Br. *obovatum* (E. Mey. ex Benth.) N.E.Br.

*Solanaceae*

*Withania somnifera* Dunal *Physalis angulata* L. *Solanum capense* L. *incanum* L. *retroflexum* Dun. *sisymbriifolium* Lam.

*Scrophulariaceae*

*Nemesia capensis* (Thunb.) Kuntze *Sutera atropurpurea* (Benth.) Hiern. *Zaluzianskya lychnidea* Walp. *Walafrida densiflora* Rolfe *Alectra sessiliflora* (Vahl) Kuntze var. *sessiliflora* *Graderia subintegra* Hiern *Cynium adonense* E. Mey. *Striga asiatica* (L.) Kuntze *bilabiata* (Thunb.) Kuntze ssp. *bilabiata* *elegans* Benth. *gesnerioides* (Willd.) Vatke

*Acanthaceae*

*Chaetacanthus costatus* Nees *Crabbea acaulis* N.E.Br. *angustifolia* Nees

*Barleria macrostegia* Nees  
*Blepharis angusta* (Nees) T. Anders.  
*Justicia anagaloides* T. Anders.

*Rubiaceae*

*Oldenlandia herbacea* (L.) Roxb.  
*Kohautia amatymbica* Eckl. & Zeyh.  
*lasiocarpa* Klotzsch  
*Pentanisia angustifolia* (Hochst.) Hochst.  
*Pachystigma pygmaeum* (Schltr.) Robyns  
*Pygmaeothamnus zeyheri* (Sond.) Robyns  
*Anthospermum rigidum* Eckl. & Zeyh.

*Dipsacaceae*

*Scabiosa columbaria* L.

*Cucurbitaceae*

*Acanthosicyos naudiniana* (Sond.) Jeffrey  
*Momordica balsamina* L.  
*Cucumis africanus* L.f.  
*anguria* L.  
*heptadactylus* Naud.  
*hirsutus* Sond.  
*myriocarpus* Naud.  
*zeyheri* Sond.  
*Trochomeria macrocarpa* Hook.f.

*Campanulaceae*

*Wahlenbergia androsacea* A.DC.  
*caledonica* Sond.  
*Cyphia assimilis* Sond.  
*Lobelia nuda* Hemsley var. *rosulata* (S. Moore) E. Wim.

*Compositae*

*Vernonia monocephala* Harv.  
*oligocephala* (DC.) Sch. Bip. ex Walp.  
*Aster muricatus* Less.  
*Nidorella hottentottica* DC.  
*resedifolia* DC.  
*Conyza bonariensis* (L.) Cronquist  
*podocephala* DC.  
*Nolletia ciliaris* (DC.) Steetz  
*rarifolia* Steetz  
*Denekia capensis* Thunb.  
*Gnaphalium micranthus* Thunb.  
*undulatum* L.  
*Helichrysum coriaceum* Sond.  
*miconiaefolium* DC.  
*nudifolium* (L.) Less.  
*Geigeria brevifolia* (DC.) Harv.  
*burkei* Harv. ssp. *burkei* var. *burkei*  
*Bidens bipinnata* L.  
*Flaveria bidentis* (L.) Kuntze  
*Tagetes minuta* L.  
*Artemisia afra* Jacq.  
*Senecio burchellii* DC.  
*coronatus* Harv.  
*filifolius* Harv.  
*harveianus* MacOwan  
*orbicularis* Sond.  
*othonnaeflorus* DC.  
*venosus* Harv.  
*verdoorniae* Dyer  
*Castalis spectabilis* (Schltr.) Norlindh  
*Osteospermum scariosum* DC.  
*Ursinia nana* DC.  
*Arctotis staechadifolia* Berg.  
*Gazania krebsiana* Less. ssp. *krebsiana*  
 ssp. *arctotoides* (Less.) Roessl.  
*Dicoma anomala* Sond.  
*Gerbera piloselloides* Cass.  
*plantaginina* Harv.  
*Lactuca capensis* Thunb.

## NUMERICAL IMPORTANCE OF THE FAMILIES

<i>Families</i>	<i>Genera</i>	<i>Spp.</i>	<i>Families</i>	<i>Genera</i>	<i>Spp.</i>
<b>PTERIDOPHYTA</b>			Resedaceae . . . . .	1	1
<i>Filicales</i>			Crassulaceae . . . . .	2	3
Polypodiaceae . . . . .	4	4	Saxifragaceae . . . . .	1	1
Marsileaceae . . . . .	1	1	Rosaceae . . . . .	1	1
			Leguminosae . . . . .	17	26
<b>SPERMATOPHYTA</b>			Geraniaceae . . . . .	2	2
<b>ANGIOSPERMAE</b>			Oxalidaceae . . . . .	1	1
<i>Monocotyledoneae</i>			Zygophyllaceae . . . . .	1	1
Gramineae . . . . .	32	62	Rutaceae . . . . .	1	1
Cyperaceae . . . . .	7	17	Polygalaceae . . . . .	1	3
Commelinaceae . . . . .	2	5	Euphorbiaceae . . . . .	3	5
Liliaceae . . . . .	14	20	Anacardiaceae . . . . .	2	4
Amaryllidaceae . . . . .	2	2	Celastraceae . . . . .	1	1
Hypoxidaceae . . . . .	1	3	Rhamnaceae . . . . .	1	1
Velloziaceae . . . . .	1	1	Tiliaceae . . . . .	2	2
Iridaceae . . . . .	4	5	Malvaceae . . . . .	3	6
Orchidaceae . . . . .	2	4	Sterculiaceae . . . . .	1	3
			Guttiferae . . . . .	1	1
<i>Dicotyledoneae</i>			Flacourtiaceae . . . . .	1	1
Ulmaceae . . . . .	1	1	Thymelaeaceae . . . . .	2	4
Urticaceae . . . . .	1	1	Lythraceae . . . . .	1	1
Santalaceae . . . . .	1	2	Umbelliferae . . . . .	1	1
Polygonaceae . . . . .	2	2	Ebenaceae . . . . .	1	2
Chenopodiaceae . . . . .	2	3	Oleaceae . . . . .	2	2
Amaranthaceae . . . . .	5	6	Gentianaceae . . . . .	1	2
Phytolaccaceae . . . . .	2	2	Asclepiadaceae . . . . .	10	17
Aizoaceae . . . . .	2	2	Convolvulaceae . . . . .	3	6
Portulacaceae . . . . .	2	3	Borraginaceae . . . . .	2	2
Caryophyllaceae . . . . .	3	3	Verbenaceae . . . . .	4	5
Ranunculaceae . . . . .	2	2	Labiatae . . . . .	4	6
Menispermaceae . . . . .	1	1	Solanaceae . . . . .	3	6
Cruciferae . . . . .	3	4	Scrophulariaceae . . . . .	8	11
Capparidaceae . . . . .	1	2	Acanthaceae . . . . .	5	6
			Rubiaceae . . . . .	6	7
			Dipsacaceae . . . . .	1	1
			Cucurbitaceae . . . . .	4	9
			Campanulaceae . . . . .	3	4
			Compositae . . . . .	22	38

## NUMERICAL STRENGTH OF THE MAJOR TAXA

	<i>Families Genera Spp.</i>		
Pteridophyta	2	5	5
Spermatophyta:			
Angiospermae:			
Monocotyledoneae	9	65	119
Dicotyledoneae:			
Archichlamydeae	36	75	104
Sympetaleae	16	79	124
	<u>63</u>	<u>224</u>	<u>352</u>

## CYTOKININ AND GIBBERELLIN EFFECTS ON ABSCISIC ACID INDUCED INHIBITION OF GROWTH IN *SPIRODELA*\*

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### ABSTRACT

The effects of cytokinins and gibberellic acid on the inhibition of growth by abscisic acid was investigated in *Spirodela oligorrhiza*. The cytokinins; benzyladenine, kinetin and 6-y, y-dimethylallallylaminopurine reversed the inhibitory effect of abscisic acid on growth, although they were not equally effective in doing so. Benzyladenine was the most effective in overcoming growth inhibition by abscisic acid. Gibberellic acid, however, proved ineffective in reversing the inhibitory effect of abscisic acid. The apparent increases in growth obtained in a number of cases may result from the fact that gibberellic acid stimulates growth; it probably does not involve an interaction with abscisic acid.

### UITTREKSEL

**DIE INVLOED VAN SITOKINIEN EN GIBBERELLIEN OP ABSISSIENSUUR-GEÏNDUSEERDE GROEISTREMMING BY *SPIRODELA*.** Die invloed van sitokiniene en gibberelliensuur op absissiensuur-geïnduseerde groeistremming by *Spirodela oligorrhiza* is ondersoek. Die inhiberende effek van absissiensuur op groei is oorkom deur kinetien, bensieladenien en 6-y, y-dimietielallielaminopurien. Van die drie sitokiniene was bensieladenien die doeltreffendste om die inhiberende werking van absissiensuur te oorkom. Gibberelliensuur kon nie die inhiberende werking van absissiensuur oorkom nie. Die skynbare toename in groei wat in 'n aantal gevalle opgemerk is, is waarskynlik toe te skryf aan die feit dat gibberelliensuur groei stimuleer, en nie as gevolg van 'n interaksie met absissiensuur nie.

### INTRODUCTION

A number of investigations have shown that the inhibitory effects of abscisic acid on protein synthesis, germination and growth can be overcome by the cytokinins (Van Overbeek, Loeffler and Mason 1967, Khan 1968, Khan and Downing 1968, Sankhla and Sankhla 1968, Khan 1969). When applied together with abscisic acid, benzyladenine and other purine derivatives have been found to reverse to a large extent the inhibitory effect of abscisic on the growth of *Lemna minor* (Van Overbeek *et al.* 1967, Van Overbeek 1968). However, this antagonism was not shown by gibberellic acid which appeared to have no promotive effect on the growth of *Lemna* in either the presence or absence of abscisic acid. Khan (1968) showed that the gibberellin-induced germination of

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\* This research was supported by a grant from the Council for Scientific and Industrial Research, Pretoria, Republic of South Africa.

Accepted for publication 17th April, 1970.

Grand Rapids lettuce seed in the dark was inhibited by abscisic acid. This inhibition was reversed by kinetin and benzyladenine, but not by an excess of gibberellin. Likewise, gibberellin failed to counteract the inhibition by abscisic acid of  $\alpha$ -amylase synthesis and coleoptile growth in intact barley seeds, although in combination with kinetin it caused a nearly complete reversal of  $\alpha$ -amylase synthesis. This combination of kinetin and gibberellin, however, was unable to bring about the complete reversal of the abscisic acid-inhibited coleoptile growth. Kinetin possibly acts by removing the abscisic acid inhibition of enzyme specific sites thereby allowing gibberellic acid to function to produce  $\alpha$ -amylase (Khan and Downing 1968).

Chrispeels and Varner (1966), on the other hand, have reported that gibberellin-induced  $\alpha$ -amylase synthesis in excised barley aleurone is inhibited by abscisic acid but partially reversed by excess gibberellin. Villiers' (1968) microautoradiographic study of the effects of abscisic acid and gibberellin on dormancy in *Fraxinus* lends support to the suggestion by Thomas, Wareing

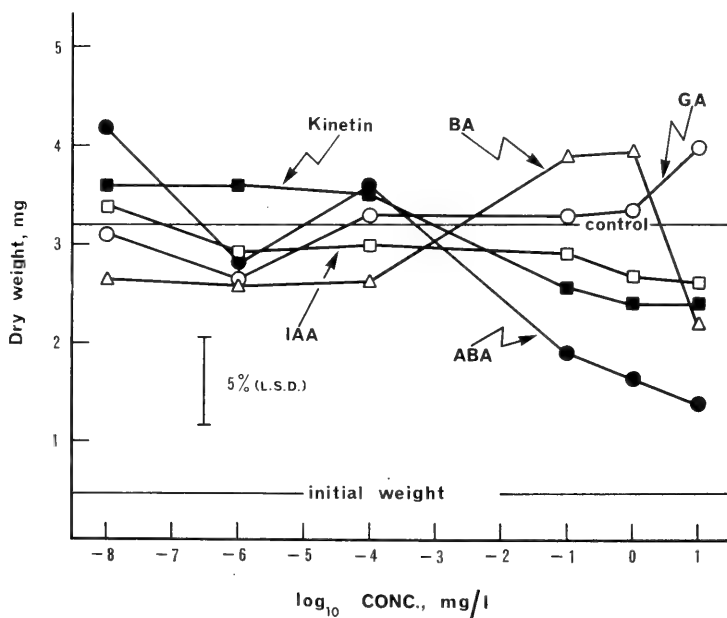


FIG. 1.

Effect of increasing concentrations of abscisic acid, gibberellic acid, kinetin, indoleacetic acid, and benzyladenine on the dry weight of *Spirodela*. Each point on the curves represents the mean of six replications. (L.S.D. = Least significant difference.)



and Robinson (1965) and Aspinall, Paleg and Addicott (1967) that abscisic acid acts antagonistically towards gibberellin.

In view of the antagonisms which have been established and the apparent anomalies in connection with the actions and interactions of abscisic acid, gibberellin and the cytokinins, it was decided to examine some of the effects of the hormones applied, alone and in combination with one another, on the growth of *Spirodela*.

#### MATERIAL AND METHODS

*Spirodela oligorrhiza* (Kurz) Hegelm. was grown in 50 ml erlenmeyer flasks in 30 ml sterile, full-strength Hoagland's solution containing the various test compounds. The nutrient solution was adjusted to pH 4.6 before the addition of the different hormones. Fe-EDTA was used as a source of iron. Each flask, containing six sterile two-frond plants, was aerated for 45 minutes twice daily with air sterilized by passing it through a Swinnex adapter fitted with a Millipore GS 0.22 $\mu$  filter disc. The cultures were maintained at  $24 \pm 2^\circ\text{C}$  under a 16 hour photoperiod of ca.  $3.0 \times 10^8$  lm/m<sup>2</sup>. Each treatment consisted of six replications. Growth was measured as the increase in dry weight 12 days following their introduction into the culture medium.

Kinetin (6-furfurylaminopurine), 6-benzylaminopurine (BA) and 6-y, y-dimethylallallylaminopurine (DMAAP) were purchased from California Corporation for Biochemical Research. Gibberellic acid (potassium salt) (GA) was obtained from Koch-Light Laboratories, England. (RS)-abscisic acid (ABA) was donated by R. J. Reynolds Tobacco Company, North Carolina, U.S.A.

#### RESULTS AND DISCUSSION

*Effects of abscisic acid, kinetin, indoleacetic acid, gibberellic acid, and benzyladenine on growth.* The effects on the growth of *Spirodela* of ABA, IAA, GA, BA and kinetin applied singly at different concentrations are shown in Figure 1. Abscisic acid strongly inhibited growth at concentrations of 0.1 to 10.0 mg/l. As previously reported it accelerated growth at a concentration of  $10^{-8}$  mg/l (Van Staden and Bornman, 1969).

At a level of 10.0 mg/l, kinetin, BA and IAA reduced growth while GA resulted in an increase in dry weight. Van Overbeek *et al.* (1967), however, reported that GA had no such effect on the growth of *L. minor*. Concentrations of 0.1 mg/l and 1.0 mg/l of kinetin also resulted in decreases in the dry weight of *Spirodela* whereas at the same levels BA accelerated growth by about 22 per cent over that of the control. These results obtained for IAA and BA are in agreement with those reported by Van Overbeek *et al.* (1967) for *Lemna*.

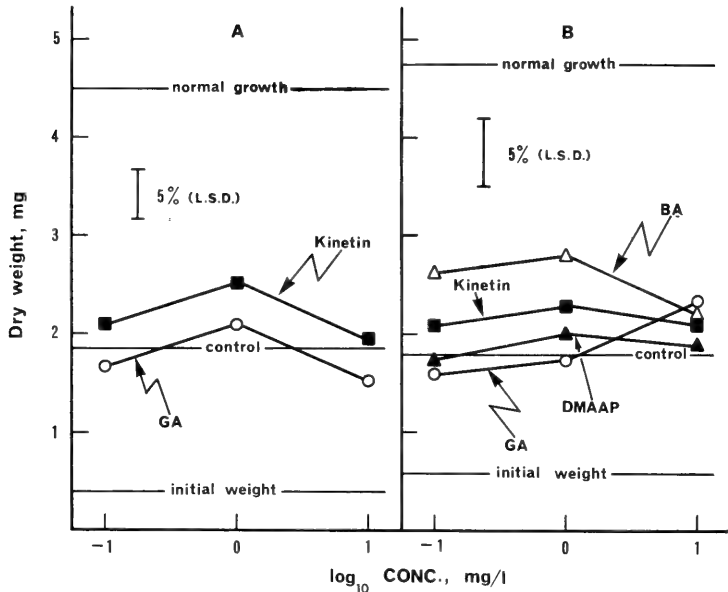


FIG. 2.

A. Effects of three concentrations of gibberellic acid and kinetin on the dry weight of *Spirodela* in the presence of 0.1 mg/l ABA. B. Effects of three concentrations of gibberellic acid and cytokinins (BA, kinetin, DMAAP) on the dry weight of *Spirodela* in the presence of 1 mg/l ABA. Each point on the curves represents the mean of six replications. (L.S.D. = Least significant difference.)

It must, however, be pointed out that in those cases where relatively high concentrations (1.0 and 10.0 mg/l) of IAA were applied the auxin was apparently photo-inactivated. This severely affected the growth of the plants. It was therefore decided not to use IAA in further experiments. Concentrations of the hormones below 0.1 mg/l generally appeared to have very little effect on growth.

*Effects of cytokinins and gibberellin on the inhibition of growth by abscisic acid.* As shown in Figure 1 abscisic acid greatly inhibited growth at levels of 10.0, 1.0, and 0.1 mg/l. The comparative effects of some cytokinins and GA, on ABA-inhibition of growth at different levels are shown in Figure 2. Figure 2A shows that the inhibitory effect of 0.1 mg/l ABA was significantly reversed by 1.0 mg/l kinetin but not by 10.0 mg/l. This decrease in the response to kinetin can probably be attributed to the fact that kinetin at 10.0 mg/l inhibits the growth of *Spirodela* (Figure 1). Where ABA was supplied at the rate of

1.0 mg/l its inhibitory effect on growth was reversed only by BA at 0.1 and 1.0 mg/l (Figure 2B). Otherwise, the compounds tested had no significant effect on the growth inhibition by ABA. Another interesting observation, also reported by Khan and Downing (1968), is that with an increase in ABA concentrations, kinetin becomes less effective in reversing growth inhibition by this regulator.

Of the three cytokinins investigated, BA was the most effective while DMAAP was the least effective in reversing ABA-inhibited growth. A very interesting observation is the striking similarity shown by the curves for kinetin, BA and DMAAP. These curves agree closely with those published by Khan (1969) for the reversal of ABA-inhibited growth by kinetin and BA in barley seed.

Khan (1969) postulated that the slight increase in coleoptile growth of barley

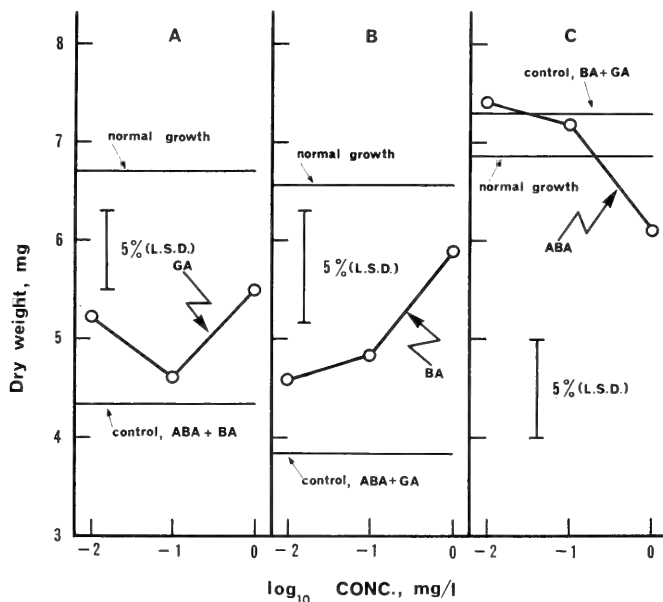


FIG. 3.

The effect of increasing concentrations of: A, gibberellic acid in the presence of 1 mg/l each of ABA and BA; B, benzyladenine in the presence of 1 mg/l each of ABA and GA; and C, abscisic acid in the presence of 1 mg/l each of BA and GA; on the dry weight of *Spirodela* after 12 days growth. Each point on the curves represents the mean of six replications. (L.S.D. = Least significant difference.)

by GA plus ABA over ABA alone may reflect an overall stimulation of growth by GA and is probably not a true reversal of ABA inhibition by GA. The present results may perhaps be interpreted similarly (compare Figures 1 and 2B).

Because no decisive result was obtained as to whether GA could overcome the inhibitory effect on growth by ABA, it was decided to investigate the combined effects of ABA, BA, and GA on the growth of *Spirodela*.

If *Spirodela* was grown in the presence of 1.0 mg/l each of ABA and BA, growth was 65 per cent of normal. However, with the addition of 1.0 mg/l of GA growth was increased to 82 per cent of normal. This showed that BA and GA combined cannot completely counteract the effect of ABA (Figure 3A). Khan and Downing (1968) reported that a combination of GA and kinetin did not bring about the reversal of ABA inhibition of coleoptile growth to any greater extent than that achieved by the two hormones separately. The present findings seem to indicate that although GA is unable to overcome the inhibitory effect of ABA on its own, it may do so in combination with the cytokinins. It is, however, also possible that this increase in dry weight was the result of increased growth and is not a reflection of an interaction between ABA and GA. Sankhla and Sankhla (1968), reported that although GA was completely ineffective in reversing the inhibition of germination of lettuce seeds caused by ABA, it exerted a stimulating effect on seedling growth as a result of which the seedlings exhibited an increased hypocotyl elongation.

Where *Spirodela* was grown in the presence of 1.0 mg/l each of ABA and GA an increase in the concentration of BA progressively increased growth (Figure 3B). Benzyladenine and GA (1.0 mg/l of each) stimulated growth above the normal level. Absciscic acid at concentrations of  $10^{-2}$  and  $10^{-1}$  mg/l did not counteract the combined effects of BA and GA. However, it was effective at 1.0 mg/l (Figure 3C).

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## **BYDRAE TOT DIE MORFOLOGIE EN ANATOMIE VAN ROMULEA: I. DIE KNOL**

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### **SAMEVATTING**

'n Vergelykende studie van die knolstruktuur van nagenoeg 50 Suid-Afrikaanse *Romulea*-species is gemaak. Die knolle wat bedek is met harde, gladde tunicae, word ingedeel volgens hul vorm en die splete wat aan die basis in die tunicae ontstaan om die wortels deur te laat. Twee hooftypes kan onderskei word, t.w. 'n simmetriese klokvormige knol met 'n plat ronde basis, en asimmetriese knolle wat óf 'n skerp, dwars, halfmaanvormige rif by die basis het, óf afgerond of gepunt is aan die basis. Die knolle met die halfmaanvormige rif word verder ingedeel volgens die splitsing van die tunicae op die rif en die wydte van die rif. Die knolle met afgeronde of gepunte basisse het tunicae met lengtesplete. Hierdie kenmerke is konstant by die Suid-Afrikaanse species en is bruikbaar om hulle in te deel.

### **ABSTRACT**

**CONTRIBUTION TO THE MORPHOLOGY AND ANATOMY OF ROMULEA: I. THE CORM.** A comparative study of the structure of the corm of about 50 South African species of *Romulea* has been carried out. The corms, covered with hard, smooth tunics, are classified according to their shape and the type of splits forming in the tunics to allow the roots to emerge. Two principal corm types can be identified, viz. a symmetrical, campanulate corm with a flat circular base, and asymmetrical corms which either have a sharp, transverse, crescent-shaped ridge at the base, or are rounded or pointed at the base. The corms with a crescent-shaped ridge are further classified according to the splitting of the tunics on the ridge and the width of the ridge. The corms with rounded or pointed bases have longitudinal splits in the tunics. These characters are constant in the South African species and are of value in their classification.

### **INLEIDING**

Diels (1930) het verklaar dat die afgrensing van die species van die genus *Romulea* nog baie onseker is, „und bedarf eingehenden Studiums in der Heimat“. Omdat die toestand vandag nog nie verbeter het nie, trouens vererger is deur die ontdekking van verskeie nuwe species, is besluit om 'n noukeurige sitologiese en morfologiese ondersoek van die Suid-Afrikaanse species uit te voer. In die loop van die ondersoek het geblyk dat sekere anatomiese kenmerke, bv. van die knol en blare, van groot waarde is vir 'n beter insig in die genus. In hierdie artikel word die knolbou bespreek as voorafgaande studie tot 'n hersiening van die Suid-Afrikaanse *Romulea*-species.

In 'n paar genera van die Iridaceae was die kenmerke van die knol en knol-skubbe van waarde vir die taksonomie. Rendle (1930) wys daarop dat die

knol se grootte en vorm, en veral die kenmerke van die omhullende knolskubbe, 'n manier daarstel om die talryke species van *Crocus* en van *Gladiolus* te onderskei, en Foster (1941) het die aard van die knoltunicae van *Geissorhiza* gebruik as 'n diagnostiese kenmerk by sy hersiening van die genus, Lewis (1954 p. 66) verklaar: „those who are familiar with the family” (d.i. Iridaceae) „can frequently recognise the genus, or in some cases the species, or group of species to which a plant belongs by the characteristic shape or distinct fibrous tunics of the corm”.

By *Romulea* word die knolkenmerke selde vermeld in beskrywings van die species, Die enigste uitvoerige beskrywings wat in die ouer literatuur gevind is, is dié van twee Kaapse soorte destyds bekend as *Ixia bulbocodioides* Delar. (1766) en *I. filifolia* F. Delar. (1809). In sy monografie oor *Romulea* het Béguinot (1907 p. 76, 78) slegs 'n paar sinne aan 'n algemene beskrywing van die knol gewy, waarskynlik omdat hy die Kaapse soorte byna uitsluitlik in die vorm van herbariummateriaal geken het, en omdat al die Europese soorte één algemene knoltipe toon. Hy bestempel die knol as 'n „bulbo-tuberoso” omdat dit uit gewysigde blare en 'n verknolling („tuberification”) van die stingelas bestaan. Hy vermeld verder dat die knol wat in die jong toestand reëlmatig eivormig is, later aan die een kant afgeplat word na die basis. Hierdie bou kom by die Europese soorte voor.

In die meer resente literatuur het Lewis (1950) onder andere van die knolkenmerke gebruik gemaak om die *Romulea*-species in die Kaapse Skiereiland te bepaal, en hier, asook in 1954 onderskei sy tussen die plat-basis-knol van bv. *R. triflora* N.E. Br., die knol van bv. *R. bulbocodioides* Bak. wat skeef afgeplat is aan die basis, en die byna bolronde knol van *R. rosea* Eckl.

Die huidige ondersoek het aan die lig gebring dat nie alleen die vorm van die knol nie, maar ook die tipe van spleet of splete wat in die knoltunicae ontwikkel om die wortels deur te laat, van belang is vir die indeling van die Suid-Afrikaanse romuleas.

#### MATERIAAL EN METODEDES

Vars materiaal van ongeveer 50 *Romulea*-species wat versamel is vanaf Namakwaland tot in Oos-Kaapland vir die sitologiese ondersoek, is ook vir die huidige anatomiese studie gebruik.

Nadat die ouer tunicae van vorige jare verwyder is, is die knolle met 'n ontleedmikroskoop wat 10- of 20-maal vergroot, ondersoek.

Die knoltunicae wat in die volwasse stadium steenhard is, is gekook om sag te maak en die lug uit te dryf, of anders is jong stadiums vir sneë gebruik. Handsneë is van die knolle en tunicae gemaak en in gliserienjellie gemonteer. Mikrotroomsneë 15 $\mu$  dik is van knoldele gemaak, met safranien en Delafield se haematoksilien gekleur en permanent gemaak. Stukke tunicae is volgens die



metode van Jeffrey gemasereer om die aard van die sklerenchiem na te gaan. Die gewone mikrochemiese toetse vir selwande en kristalle is uitgevoer.

Met die intensiewe versameling van romuleas, is 'n hele aantal nuwe spesies ontdek waarvan van sommige die beskrywings nog nie gepubliseer is nie. Waar dit nodig is vir die huidige werk, word hul ongepubliseerde name genoem, met „n. sp. ms. nom.” bygevoeg. Die beskrywings volg later. 'n Aantal van die seksies wat genoem word, is dié van Béguinot (1907-09), t.w. *Hirsutae*, *Hirtae*, *Roseae* en *Tortuosae*. Dit is egter nodig gevind om verskeie nuwe seksies te maak, en hul beskrywings sal ook later gepubliseer word.

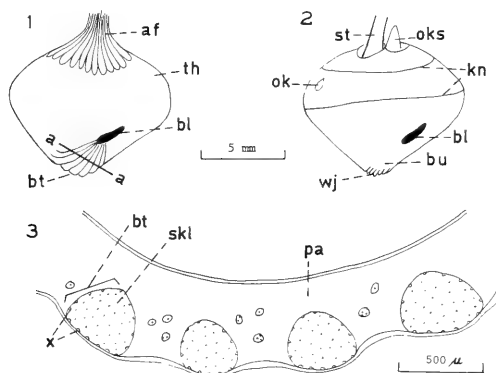


FIG. 1.

Knol van die rosea-tipe met slegs die jongste tunica behoue (Maart-April): af, apikale fibrille; bl, basale litteken; bt, basale tande; th, harde „hoof”-tunica.

FIG. 2.

Soos fig. 1, maar met al die tunicae verwyder: bl, basale litteken; bu, basale uitstulping; kn, knoop; ok, okselknop; oks, spruitende okselknop; st, ou stingelbasis; wj, jong ontwikkelende bywortels.

FIG. 3.

Dwarssnede deur vier van die jong basale tande op hoogte a-a van fig. 1: bt, basale tand; pa, parenchium wat later vergaan; skl, sklerenchiem van basale tande; x, kristalle.

## ONDERSOEK

Die genus besit 'n gerokte knol (vgl. Lewis 1954) wat uit 'n klein aantal opgeswelde internodia bestaan en bedek is met 'n paar harde gladde tunicae wat die ou blaarbasisse is (fig. 1, 2). Aan die begin van die groeiseisoen groei 'n aantal bywortels uit die knol en ontwikkel sy boonste okselknop tot 'n blomdraende spruit. Die paar basale internodia van hierdie spruit swel geleidelik op tot om 'n nuwe knol te vorm, terwyl die voedsel van die oue geleidelik opgebruik word.

Die vertakking is simpodiaal, soos by *Crocus* (Reinders 1957), en elke knol leef van die een groeiseisoen tot die volgende, wanneer dit deur die nuwe knol vervang word.

Die knol het goed-onderskeibare sentrale stele wat vanaf die aanhegtingsplek van die ou knol opwaarts strek na die verlengde stingel (fig. 4, 5).

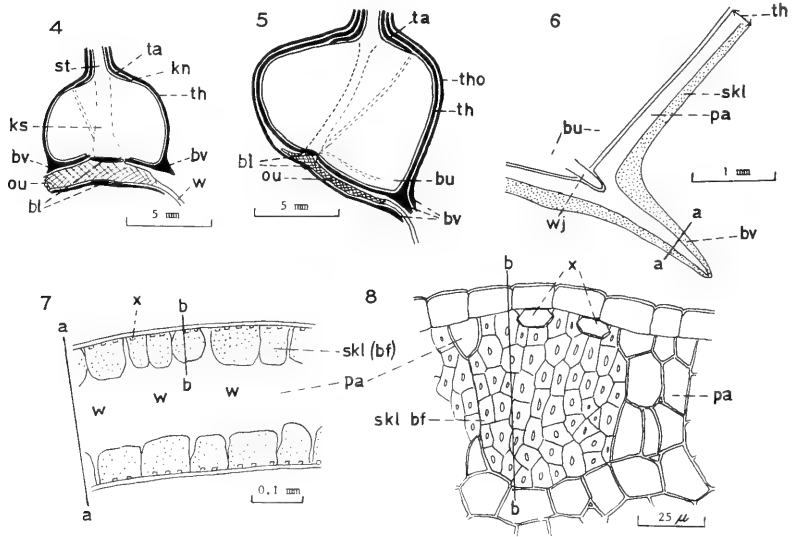


FIG. 4.

Lengtesnee deur die hirsuta-tipe knol (Augustus–September) met tunicae van vorige jare verwyder en funksionerende bywortel vas aan oorblyfsel van vorige knol: bl, basale litteken; bv, basale vou; kn, knoop; ks, stele; ou, oorblyfsel van vorige knol; st, stingel; ta, apikale tunica; th, harde „hoof”-tunica; w, funksionerende bywortel.

FIG. 5.

Lengtesnee deur die ciliata- of aggregata-tipe knol met oorblyfsels van vorige knol en sy tunica (Augustus–September): bl, basale litteken; bu, basale uitstulping; bv, basale vou; ou, oorblyfsel van vorige knol; ta, apikale tunica; th, harde „hoof”-tunica; tho, „hoof”-tunica van vorige knol.

FIG. 6.

Lengtesnee deur basale vou van die tunica van die ciliatatipe knol (April): bu, basale uitstulping van knol; bv, basale vou; pa, parenchium; skl, abaksiale sklerenchiellaag; th, harde „hoof”-tunica; wj, jong ontwikkelende bywortel.

FIG. 7 and FIG. 8.

Fig. 7. Dwarssnee deur basale vou van tunica op hoogte a-a van fig. 6, om die parallelle tye basale fibrille te toon. Fig. 8. Dwarssnee deur een basale fibril b-b van fig. 7, nog omring met parenchium wat later vergaan: pa, parenchium; skl(bf), sklerenchiem van basale fibrille; w, posisie van ry bywortels; x, subepidermale kristalle.

Rondom die stele is die verbrede skorsgedeelte wat die reserwevoedsel, hoofsaaklik setmeel, bevat.

Die nuwe knol is aan die oue verbind met 'n smal nekkie wat 'n ronde of ovale litteken van 2—3 mm in deursnee nalaat, hier genoem die basale litteken (bl in fig. 1, 2, 4, 5). Rondom die basale litteken besit die nuwe knol twee of drie of soms tot vyf blare. Hulle is laagteblare en by sommige spesies is die hoogste een die eerste basale loofblaar. Die internodia tussen hierdie blare is uitermate verkort.

Die opgeswelde deel van die knol bestaan uit slegs  $1\frac{1}{2}$  (fig. 4, 5) tot drie of soms vyf opgeswelde internodia (fig. 2). Een of twee van hulle is baie groot opgeswel en vorm die grootste gedeelte van die knol. Naby die top van die knol is daar een of twee knope (kn in fig. 2, 4) en by sommige spesies, bv. *R. rosea*, is daar ook 'n knoop min of meer in die middel van die knol. By baie spesies is daar min variasie in die aantal opgeswelde internodia wat die knol vorm, maar by ander, bv. *R. rosea*, wissel die aantal internodia effens met die ouderdom van die plant.

**Wortels.** Behalwe by die soorte met klokvormige knolle, is die *Romulea*-knol asimetries (dorsiventraal plagiotroop, volgens Troll 1937 p. 785), met die basale litteken wat die werklike basis van die knol voorstel, na die een kant verskuif, en met 'n basale uitstulping in die vorm van 'n rif of knop aan die basis (bu in fig. 2, 5). Bywortels groei uit die basale uitstulping (wj in fig. 2, 6). By die kiemplant word hierdie uitstulping teenoor die saadlob gevorm en by latere knolle in die daaropvolgende jare ontwikkel dit meestal bo die primêre een. Die bywortels wat aan die begin van die groeiseisoen vanuit die ou knol ontwikkel het, is die enigstes om die plant, ook die jong knol, te voorsien tot aan die einde van die groeiseisoen.

'n Trekwortel word gevorm slegs wanneer die knol heeltemal te hoog in die grond is, bv. by kiemplant. Dit ontwikkel by die basale litteken.

Wanneer die ou knol inmekaar krimp, werk sy stele as 'n trekwortel met 'n beperkte aksie en trek die nuwe knol af tot binne in die tunicae van die oue. Die oorblyfsels van die ou knol bly as 'n plat droë aanhangsel tussen die tunicae (ou in fig. 5), en die ouderdom van die plant kan by sommige spesies bepaal word deur die ou knoloorblyfsels te tel.

**Vegetatiewe vermeerdering.** Twee nuwe knolle ontstaan wanneer die boonste twee okselknoppe van 'n knol tot spruite ontwikkel. Elkeen van die spruite vorm aan sy basis sy eie jong knol. Die susterknolle, wat heeltemal selfstandig word wanneer die ou knol vergaan, bly teenmekaar en word saam bedek deur die ou knoltunicae van vorige jare, wat later oopsplits.

Daar kom nie ondergrondse uitlopers voor nie waardeur 'n jong knol 'n endjie van die moederplant gevorm kan word, soos by *Crocus*-soorte (Reinders 1957) of *Gladiolus*-soorte.

*Die knoltunicae.* Die blaarbasisse wat vas is rondom die basale litteken van die knol, vorm die knoltunicae. Een van hulle verhout en word harder as die ander, om die steenharde, gladde, „hoof”-tunica te vorm (th in fig. 1, 4, 5). Dit kan een van die laagteblare wees of die eerste loofblaar. Die hardheid daarvan word veroorsaak deur verandering van die buitenste (abaksiale)

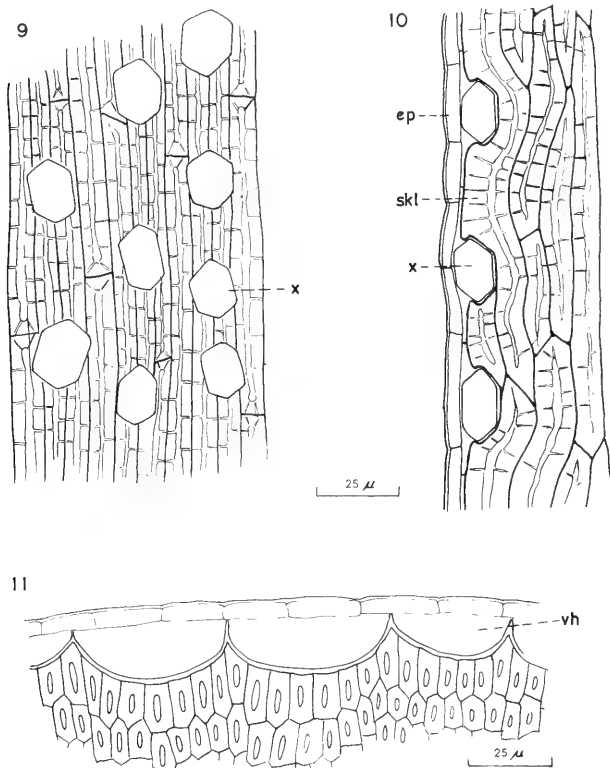


FIG. 9.

Oppervlakte van tunica van *R. flava* met die epidermis verwyder, om die subepidermale kristalle (x) bo-op die abaksiale sklerenchiemlaag te toon.

FIG. 10.

Lengtesnee deur die abaksiale sklerenchiemlaag van die tunica in fig. 9 getoon: ep, epidermislaag wat later afskilwer; skl, sklerenchiem; x, subepidermale kristal.

FIG. 11.

Dwarsnee deur die abaksiale sklerenchiemlaag van die tunica van *R. setifolia*, met groot subepidermale selle wat vlak holtetiies (vh) vorm wanneer die epidermis afskilfer.

helfte van die kostale en interkostale mesofil tot 'n aaneengeslote digte laag sklerenchiem (fig. 6), hoofsaaklik verlengde skleriede, met selle van baie uiteenlopende vorms. Die ander blaarbasisse vanuit die basale litteken bly parenchimaties en word dun en vliesig droog.

Blaarbasisse vanaf die knope hoër op teen die knol verhout ook en vorm kort musvormige tunicae wat die top van die knol bedek (ta in fig. 4, 5).

Al hierdie blaarbasisse is geslote en skeur in later jare oop wanneer die nuwe knol binne in te groot word (fig. 31).

By 'n aantal seksies, bv. Ciliatae, Aggregatae, Minutiflorae, ontwikkel 'n skerp dwars vou deur interkalêre groei, in die jong tunicae waar hulle oor die basale uitstulping strek (bv in fig. 5, 6). Hierdeur ontstaan 'n hoefvormige basale rif (fig. 15–24). By die Hirsutae en Amoebae is die basale rif sirkelvormig (fig. 4, 12–14). By die Roseae, Atrandrae ens. lê die tunicae egter glad oor die afgeronde basale uitstulping, sonder om daar 'n skerp dwars vou te vorm (fig. 28, 29).

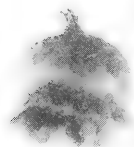
By die meeste spesies word die „hoof“-tunica verder versterk deur die ontwikkeling van 'n kristallaag met kalsiumoksalaatkristalle in die buitenste (abaksiale) subepidermale laag (fig. 9, 10). Die kristalle is byna isodiametries of effens verleng, soms heelwat verleng, en stem ooreen met die kort subepidermale kristalle wat in die blare van sommige seksies aangetref word. Die epidermislaag van die tunica verhout nie en skilfer af as 'n dun droë vliesie, maar die kristalle wat dan oppervlakkig lê, bly in posisie, stewig vasgeklem in hul selle deur die noupassende antiklinale selwande van die aangrensende dikwandige selle (fig. 10).

By enkele spesies, t.w. *R. setifolia* N.E. Br., *R. hybrida* Beg., en *R. sladenii* (n. sp., ms. nom.) is die kristallaag afwesig en is die tunica-oppervlakte oortrek met vlak holtetjies te sien met 'n lens, wat nagelaat is deur groot subepidermale selle, 30–50  $\mu$  lank en breed, wat verskeur word wanneer die epidermis afskilfer (fig. 11).

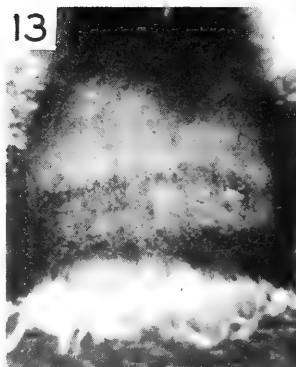
Aan die top van die knol asook op die basale uitstulping word die lignien en kristalle van die tunicae in verskillende patrone neergelê wat alterneer met stroke onverhoude parenchiem sonder kristalle (fig. 7, 26, 27). Later vergaan die sagter parenchiem en die verhoude dele vorm harde vesels of tande, omgewe deur 'n kristallaag (fig. 3, 27). Aan die top van die knol is die harde dele aanwesig as lang spits tande wat styf rondom die stingelbasis klem (fig. 1, 23, 31). Op die basale rif is hul as dun parallelle fibrille of klein fibrilgroepies aanwesig, of vorm hulle gebuigde of reguit, spitslopende tande (fig. 17, 19, 21, 28, 34). Die bywortels groei deur die splete wat tussen die harde tande of fibrille ontstaan wanneer die sagte, parenchimaties-blywende dele van die tunica vergaan.

*Knoltipes.* By die Suid-Afrikaanse romuleas kom verkillende knoltipes voor, met die tunicae op verskillende maniere aan die basis gesplits. Hierdie kenmerk

12



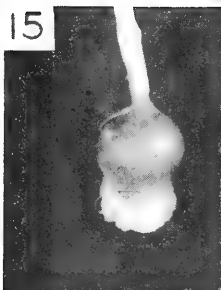
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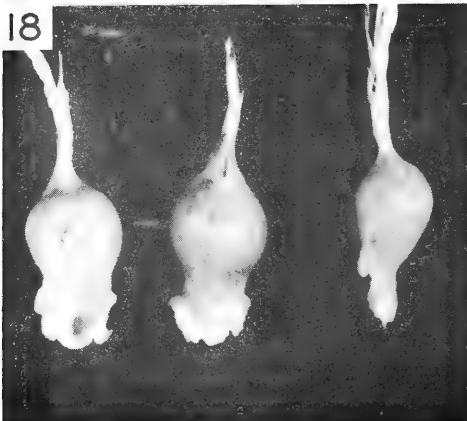
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19



het geblyk van belang te wees vir die indeling van die spesies. Twee hooftipes, wat in verskeie onderafdelings ingedeel kan word, word onderskei:

A. Simmetriese, klokvormige knolle met die basale litteken sentraal op 'n ronde basale skyfie en 'n sirkelvormige basale rif rondom die rand van die skyfie (fig. 1). Hiertoe behoort die seksies *Hirsutae* en *Amoenae*, die eersgenoemde met parallelle fibrille op die basal rif (*hirsuta*-tipe, fig. 12, 13), en die laasgenoemde met uiters klein fibrilgroepies dáár (*amoena*-tipe, fig. 14).

B. Asimmetriese knolle met die basale litteken in 'n sydelinkse posisie (dorsiventraal-plagiotroop, Troll 1937). Die verdere indeling is soos volg:

1. Knolle met 'n U-vormige of halfmaanvormige basale rif.
- 1.1 Die *ciliata*-tipe met die tunicae wat in parallelle rye van fyn fibrille op die basale rif splits, bv. seksies *Ciliatae*, *Aquaticae*, *Macowania* (fig. 15–17).
- 1.2 Die *spatulata*-tipe van die seksie *Minutiflorae*, met 'n smal, hoë, nagenoeg spatelvormige basale rif wat dikwels ook in parallelle fibrille splits of ongesplits bly (fig. 18, 19.)
- 1.3 Die *tortuosa*-tipe van die seksie *Tortuosae*, met 'n wye, waaivormige basale rif wat dikwels in onreëlmatige fibrille gesplits is (fig. 20, 21).
- 1.4 Die *aggregata*-tipe van die seksie *Aggregatae*, met rye uiters klein veselgroepies op die basale rif (fig. 22–27). 'n Bywortel groei deur die top van elke veselgroepie.
2. Knolle met 'n afgeronde of gepunte basis.
- 2.1 Die *rosea*-tipe waar die knol afgerond is aan die basis, met sterk, toegespitste, gebuigde tande wat na die kant van die basale litteken buig, bv. die *Roseae*, *Atrandrae* en *Hirtae* (fig. 28–30).
- 2.2 Die *cruciata*-tipe met 'n gepunte basis en sterk, reguit tande wat na die basale punt konvergeer, bv. die subseksie *Cruciatae* (fig. 31, 32).
3. Intermediêr tussen die *cruciata*- en die *ciliata*-tipe is die *autumnalis*-tipe van die seksie *Autumnales*, met 'n uiters klein basale rif wat die knol byna puntig aan sy basis maak (fig. 33, 34).

In die *hirsuta*-, *ciliata*-, *tortuosa*-, en *spatulata*-tipes vorm die knoltunicae die reeds genoemde skerp dwars vou op die basale rif. Die wortels wat in 'n ry ontwikkel, groei met hul punte in die vou in (fig. 6) en forseer vir hulle 'n weg deur 'n swak streek in die top van die vou, waar die tunica oopsplits. Aan weerskante van die spleet splits die tunicae verder om die rye fyn parallelle of onreëlmatige fibrille te vorm (fig. 7, 16–19). By die *hirsuta*-tipe verskyn wortels slegs aan die een kant van die sirkelvormige rif.

In die *amoena*- en *aggregata*-tipes is die knoltunicae ook gevou oor die basale rif, maar die wortels forseer hul weg deur 'n ry onverhoude kolletjies in die top van die vou, elke kolletjie geleë in die middel van 'n klein fibrilgroepie op die rif (w in fig. 25–27). Eers later breek die tunica verder tussen die swak kolletjies om 'n dwars spleet te vorm.

By die *rosea*-tipe groei die bywortels deur swak, onverhoude lengtesplete

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FIGS. 12–19. Knoltipes.

Fig. 12, 13, van *R. hirsuta* (*hirsuta*-tipe) met parallelle basale fibrille.

Fig. 14, van *R. amoena* (*amoena*-tipe).

Fig. 15–17, van *R. leipoldtii* (*ciliata*-tipe) met parallelle basale fibrille.

Fig. 18, 19, van *R. minutiflora* (*spatulata*-tipe) met hoë basale rif.

Fig. 12, 15, 16, 18, natuurlike grootte; fig. 13, 14, 17, 19, X 4.

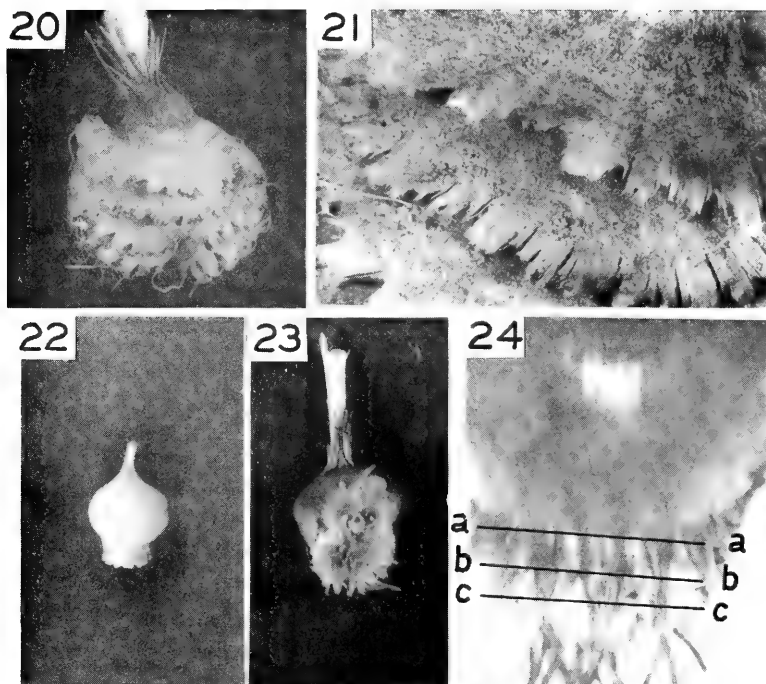


FIG. 20-24. Knoltipes.

Fig. 20, 21, van *R. tortuosa* (tortuosa-tipe) met die tunicae van vier jaar sigbaar.

Fig. 22-24, van *R. longipes* (aggregata-tipe) met basale fibrilgroepies.

Fig. 20, 22, 23, natuurlike grootte; fig. 21, 24, X 4.

wat tussen die gebuigde tande ontstaan. Die tande se punte raak vereers teen die basale litteken (fig. 1, 30), maar breek later los daarvan.

Die cruciata-tipe is naverwant aan die rosea-tipe en verskil deurdat die tunicatande so skerp gebuig is oor die basale punt van die knol, dat hulle dáár breek en die wortels, wat in 'n digte bondel uit die basale knop ontwikkel, deurlaat. Dieselfde verskynsel vind plaas by die intermediêre autumnalis-tipe, met dié verskil dat die knolbasis hier nie gepunt is nie, maar 'n baie smal riffie het (fig. 33, 34).

#### BESPREKING

Troll (1937) toon aan dat die knol van die Iridaceae uit 'n rhisoma ontwikkel het, en dat die dorsiventrale plagiotrope knol van *Romulea bulbocodium*, waar



die nuwe knol skeef aan die een kant van die oue vasgeheg is en die wortels eensydig uitspruit, nader aan die rhisoma staan as die radiaal-simmetriese ortotrope knol van die genus *Crocus*, waar die nuwe knol bo-op die oue ontwikkel en die bywortels rondom die basis van die knol uitspruit.

Die meeste Suid-Afrikaanse *Romulea*-species en al die *Romulea*-species van die noordelike halfgrond besit 'n dorsiventrale plagiotrope knol (vgl. fig. 5 van hierdie werk met Troll se fig. 620 op p. 785). Slegs by die Suid-Afrikaanse seksie *Hirsutae* en *Amoenae* kom ortotrope knolle voor, met die nuwe knol bo-op die oue (fig. 4). Hulle is egter nie akkuraat radiaal-simmetries nie, daar die bywortels alleen vanaf een helfte van die knol ontwikkel, wat die ventrale kant van die rhisoma voorstel.

Lewis (1954 p. 80) doen aan die hand dat die Iridaceae-knolle met 'n plat basis, wat by species van *Romulea* en drie ander genera (*Hesperantha*, *Geissorhiza* en *Lapeyrousia*) voorkom, taamlik primitief is en die afgeronde knolle afgelei. Sy sê ongelukkig nie of sy by *Romulea* die *hirsuta*-tipe plat-basis knol bedoel nie, of miskien ook die *ciliata*-knoltipe waar die skuins

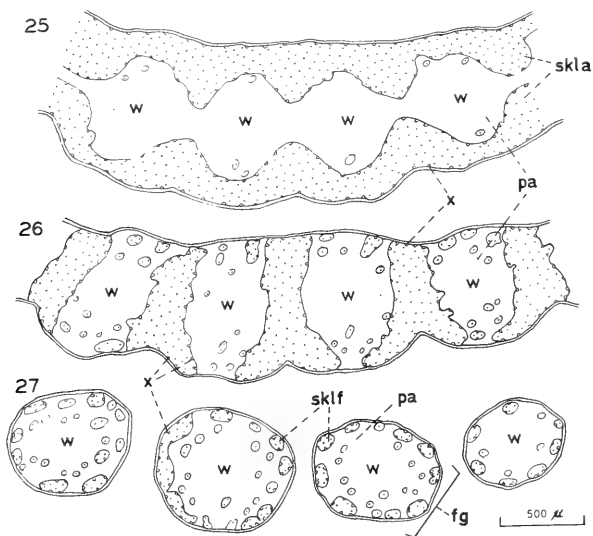


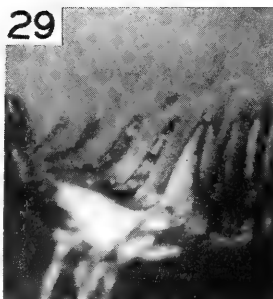
FIG. 25-27.

Dwarsneë deur die basale vou van die tunicae van die aggregata-tipe knol, op hoogtes a-a, b-b, en c-c onderskeidelik van fig. 24: fg, fibrilgroepe met 'n bywortel (w) in die sentër; pa, parenchium wat later vergaan; skla, abaksiale sklerenchiemlaag van tunica wat laer-af (fig. 27) die fibrilgroepe vorm; sklf, sklerenchiembundels; w, posisies van wortels; x, kristalle.

28



29



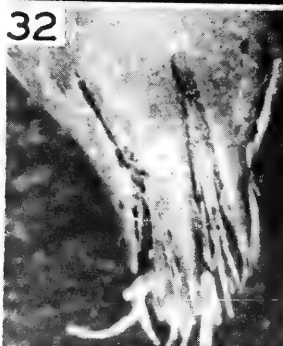
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knolbasis ook taamlik plat is. Dit is gewis dat die afgeronde en gepunte knoltipes by *Romulea* afgelei is en dat die ciliata-tipe die primitiefste vir die genus is. Hierdie 1g. tipe knol is meer dorsiventraal as die klokvormige, plat-basis hirsuta- en amoena-tipes en staan nader aan 'n rhisoma.

Lewis (1954) het verder aan die hand gedoen dat die tunicae geartikuleer is op die basale rif. Die plat deel van die tunica tussen die basale litteken waar dit aangeheg is, en die rif, het sy beskou as blaarbasis, met „the upper part (van die blaar) which is articulated to it, being the lignified base of a rudimentary petiole” (p. 80). (D.w.s. sy hang Arber (1921) se fillodeteorie oor die Iridaceae-blaar aan.) Of hierdie sienswyse van Lewis aanneemlik is, is onseker. Die „artikulasie” of basale rif in die tunica ontwikkel eers later nadat die knol self 'n skerp basale uitstulping gevorm het, en dit mag wees dat dit as gevolg van hierdie skerp uitstulping ontstaan. Knolle met 'n minder skerp uitstulping, soos die rosea-tipe, het tunicae sonder die artikulasie.

Hoewel die knolle van *Romulea* en *Crocus* dieselfde basiese bou besit, verskil hulle nie net in die reeds genoemde dorsiventrale plagiotropie (meeste romuleas) en radiale ortotropie (crocusse) nie, maar ook in die aard van die tunicae en die aantal nodia en internodia in die knol, asook in die feit dat die blomme by die romuleas later in die groeiseisoen ontwikkel nadat die blare volgroeï is en die nuwe knol reeds aan die ontwikkel is of byna volgroeï is. Die *Crocus*-plante blom vóór die blare volwasse is (Reinders 1957).

Die primitiewe ciliata-knoltipe is die wydste versprei en kom voor oor die hele verspreidingsareaal van die genus. Die meeste ander knoltipes, t.w. die hirsuta-, amoena-, tortuosa-, rosea-, en cruciata-tipes, is endemies in S.W.-Kaapland en het waarskynlik daar ontwikkel. Die spatulata-tipe kom voor vanaf S.O.-Kaapland tot W.-Kaapland, en slegs twee tipes, t.w. die aggregata-tipe in S.- en S.O.-Kaapland en die autumnales-tipe met 'n verspreiding vanaf S.O.-Kaapland tot Tanzania en Kenia, het nie die S.W.-Kaapland bereik nie.

By die Suid-Afrikaanse spesies is die knolkenmerke waardevol vir die indeling van die spesies. Die knol- en tunicabou is konstant by elke spesies, en die knoltipe kan maklik vasgestel word veral nadat die ouer, gedeeltelik verweerde tunicae verwyder is. Al die ondersoekte *Romulea*-spesies van die noordelike halfronde egter, besit knolle van die ciliata-tipe. Daar moet dus

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FIG. 28–34. Knoltipes.

Fig. 28–30, van *R. rosea* var. *reflexa* (rosea-tipe) met gebuigde basale tande en lengte splete vir die wortels.

Fig. 31, 32, van *R. cruciata* (cruciata-tipe) met spits reguit basale tande.

Fig. 33, 34, van *R. autumnalis* (autumnalis-tipe) met baie smal basale rif en parallelle fibrille daarop.

Fig. 28, 31, 33, natuurlike grootte; Fig. 29, 30, 32, 34, X 4.

van ander kenmerke gebruik gemaak word om die spesies van die Noorde in te deel.

In 'n voorlopige sitologiese ondersoek is gevind dat die verskillende knoltipes gepaard gaan met verskillende chromosoomgetalle (de Vos 1965). Verdere sitologiese ondersoek het getoon dat hierdie bewering in hoofsaak korrek is, maar dat daar tog enkele uitsonderings voorkom, waaroor later berig sal word.

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## BOOK REVIEW

*South African Aloes*: by Barbara Jeppe. xxvii, 144 pages with 139 illustrations in colour. Cape Town: Purnell, 1969. R10.00.

This attractive book is devoted to a well-known succulent genus, *Aloe*. As the title suggests, it deals only with those species found within the Republic, in South West Africa, Botswana, Lesotho and Swaziland.

The author, Mrs. Barbara Jeppe, has painted 132 species in full colour, one species to a plate, of the 139 species as at present accepted in the area dealt with; two small species filling one plate in a very few instances. Each specimen is depicted as a mature flowering plant. A most useful feature is the life-size painting of individual flowers from young bud to mature bloom. Added to these the artist has painted a small section of a leaf to show the surface pattern and type of margin or edge, together with a single mature fruit or seed vessel. These close-up details are of immense help as diagnostic features and Mrs. Jeppe is to be congratulated for such faithful reproductions of these characters. Accompanying each plate is a full page of description, its distribution, average height, flowering time and even those species of *Aloe* with which it has been known to hybridise.

The chapter on cultivation deals sensibly with the preparation of the soil, advice on planting and landscaping. Propagation by seeds and cuttings is described and there is a handy, month by month list of those species expected to flower at that time. However, *Aloe framesii*, stated to flower in June and July, is flowering at various places near the mouth of the Olifants River as these notes are written, at the end of March. That it flowers in June and July both south and north of this area is quite correct.

Pests and diseases of *Aloe* are clearly dealt with and there is sound advice on the use of insecticides and fungicides. In some instances treatment with antibiotics is advised but unless these ultra-modern aids to good gardening are much cheaper than when discovered, it might prove costly where bacterial diseases are severe.

A summary of the regulations in force for the areas dealt with in the book concerning the indiscriminate collecting of *Aloes* is a timely reminder that many species are strictly protected and Mrs. Jeppe's remarks should be read by everyone who has visions of forming an "instant *Aloe* collection" from wild specimens.

The six-page list of recorded *Aloe* hybrids in the wild state will surprise many people; with *Aloe arborescens* alone 23 other species being involved. Unlike many plant hybrids, those of *Aloe* are often remarkably fertile and seeds from these produce widely varying intermediates. In the wild state, however, the "balance of Nature" is such that very few seeds survive and natural hybrids remain comparatively scarce.

Mrs. Jeppe states that *Aloe pearsonii* is "now becoming quite rare". This slow-growing species, densely branched at ground-level, lives to a great age and, less than 10 years ago, mountain slopes in the northern Richtersveld were tinted dull red with incalculable numbers. North of Sendelingsdrif, furthermore, the same species dominated the scene for many miles. The author's note that *Aloe pillansii* occurs as far north as the Brandberg in South West Africa is of interest for all photographs of the Brandberg's "Kokerbooms" examined by the reviewer showed the tell-tale inflorescence of *A. dichotoma*. The flower-spike of *A. pillansii*, noblest of the "Kokerbooms", is unique in the genus.

The authors of the species mentioned have been faithfully given throughout the book and it is unfortunate that an error has crept in here, especially since the reason for its new name had been explained in the text. For *Aloe alooides* (Bol.) van Druten, in the text becomes, inaccurately, *Aloe alooides* Drege on the colour plate.

Mrs. Jeppe has truly succeeded in her aim in bringing to the *Aloe* enthusiast a most useful, practical and beautifully illustrated book eminently worthy of a prominent place on the bookshelf of both botanist and gardener.

H. HALL



# INSTRUCTIONS TO CONTRIBUTORS TO THE JOURNAL OF SOUTH AFRICAN BOTANY

This Journal provides a medium for the publication of the results of botanical research primarily on the flora of Southern Africa, whether systematic, morphological, ecological or otherwise and whether carried out in South Africa or elsewhere. Papers on botanical subjects of special interest and application in South Africa may be included.

Contributions must be original and should not be translations of previously published papers.

Papers must be submitted in final, corrected form. They are accepted for publication on the recommendation of the Editorial Committee.

Authors may be charged expenses for corrections if alterations are excessive.

## COPY

Papers should be type-written, double spaced throughout on one side of the paper and with margins of at least 3 cm (1 inch). Footnotes and elaborate tables should be avoided. Latin binomials should be underlined once to indicate italics. All other marking of copy should be left to the Editor. The original, plus at least one carbon copy, must be submitted.

## GENERAL LAY-OUT

Each paper should be headed with a concise informative **title** in capitals with the author's name below. This should be followed by the name of the institution, where the work was carried out, underlined and placed within brackets.

A concisely written **abstract** in English and Afrikaans, of not more than 200 words, should precede the text.

The subject matter should be divided into sections under short appropriate **headings** such as: INTRODUCTION, MATERIAL AND METHODS, RESULTS, DISCUSSION, CONCLUSION, ACKNOWLEDGMENTS, etc.

**Tables** and **illustrations** should be on separate sheets. **Figures** and **graphs** should be in Indian ink on white card or Bristol board. Lettering for figures can be inserted by the printers in which case authors should indicate the desired lettering on the original figure lightly in pencil. The maximum dimensions available for figures are 18 cm  $\times$  12 cm ( $7'' \times 4\frac{1}{2}''$ ). Line drawings for blocks should be at least twice the size they will be when reduced for publication. All figures should be supplied with a scale. The most suitable method of indicating magnification is a scale line (in metric units) incorporated in the figure. Photographs for half-tone reproductions should be on glossy paper, clearly marked on the reverse side (in pencil) to indicate the top. Line drawings and half-tone illustrations are termed figures and should be numbered consecutively. Captions for figures should be typed on a separate sheet of paper.

## TAXONOMIC PAPERS

Authors must adhere to the International Rules of Botanical Nomenclature. **Abbreviations of herbaria** must be cited in accordance with the most recent edition of Index Herbariorum, Pt 1 (The Herbaria of the World, 5th ed., 1964). When **new species** are described, the exact location of type material must be indicated. When proposing **new combinations** the full citation of the basionym is required. **Indented keys** with numbered couplets are preferred when dealing with a small number of taxa. **Bracket keys** should be used when dealing with a large number of taxa. When citing **synonyms** they should be arranged chronologically into groups of nomenclatural synonyms and these should be

arranged chronologically by basionyms. Whenever possible, the types of the basionyms should be cited, e.g.:

**Bequaertiodendron magalismontanum** (Sond.) Heine & J. H. Hemsley in Kew Bull. **1960**: 307 (1960).

*Chrysophyllum magalismontanum* Sond. in Linnaea **23**: 72 (1850). Type: Magaliesberg, Zeyher, 1849 (S, holo.; BOL!, SAM!).

*Zeyherella magalismontana* (Sond.) Aubrév. & Pellegr. in Bull. Soc. bot. Fr. **105**: 37 (1958).

*Pouteria magalismontana* (Sond.) A. Meeuse in Bothalia **7**: 335 (1960).

*Chrysophyllum argyrophyllum* Hiern, Cat. Afr. Pl. Welw. **3**: 641 (1898). Syntypes: Angola, Welwitsch 4827, 4828, 4829 (BM!).

*Boivinella argyrophylla* (Hiern) Aubrév. & Pellegr. in Bull. Soc. bot. Fr. **105**: 37 (1958).

*Chrysophyllum wilmsii* Engl., Mon. Sapot. Afr.: 47 t. 16 (1904). Type: Transvaal Wilms 1812 (B†, holo.; K!).

*Boivinella wilmsii* (Engl.) Aubrév. & Pellegr. in Bull. Soc. bot. Fr. **105**: 37 (1958).

## CITATION OF SPECIMENS

In the interests of uniformity contributors are requested to follow the recommendations of the Botanical Research Institute, Pretoria (Technical note: Gen. 4, Oct., 1967) by citing specimens according to the one degree grid system. Distribution data are given separately for each province and are arranged in the following sequences: South West Africa, Botswana, Transvaal, Orange Free State, Swaziland, Natal, Lesotho, Cape. Within each province degree squares are listed in numerical sequence, i.e., from west to east and from north to south. Whenever possible locality records should be given to within a quarter degree square. The collectors' names and numbers are underlined (printed in italics) to avoid confusion with the numbers of the degree squares, e.g.: NATAL—2829 (Harrismith): Cathedral Peak Forest Station (-CC), *Killick 1527* (PRE); . . . CAPE—3418 (Simonstown): Hottentots Holland mountains, Somerset Sneeukop (-BB), Nov., *Stokoe s.n.* sub. SAM 56390 (SAM).

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These should be given in the text as follows: Jones (1968) or (Jones, 1968) or, where reference to a specific page is required, Jones (1968:57) or (Jones, 1968:57). **Literature cited** should be arranged alphabetically by surnames, chronologically within each name, with suffixes a, b, etc., to the year for more than one paper by the same author in that year. Titles of **periodicals** must be abbreviated according to the *World List of Scientific Periodicals*, 4th ed., London: Butterworth or when unable to trace the title in this list (as will be the case in taxonomic papers where abbreviations of 18th and 19th century periodicals are required) the abbreviations given in *Botanico-Periodicum-Huntianum*, Pittsburgh: Hunt Botanical Library, 1968, should be followed. Periodical titles should be underlined once (for italics). If an author is unable to determine the correct abbreviation of a journal title he is advised to type it out in full and leave its abbreviation to the Editor. Titles of **books** should be underlined and given in full, together with the place of publication, name of the publisher and an indication of the edition if other than the first; e.g.:

Davis, P. H. and Heywood, V. H., 1963. *Principles of Angiosperm Taxonomy*. Edinburgh and London: Oliver and Boyd.

Riley, H. P., 1960. Chromosome numbers in the genus *Haworthia*. *Jl S. Afr. Bot.* **26**: 139—148.



## STUDIES IN THE BULBOUS LILIACEAE: 1. *SCILLA*, *SCHIZOCARPUS* AND *LEDEBOURIA*

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### ABSTRACT

Cytological, anatomical and chromatographic work on the genus *Scilla* sensu lato in South Africa is reviewed. Evidence relating to the best generic grouping of these species is discussed and a key produced to the species of the two genera, *Scilla* and *Ledebouria*, recognised. Four species are recognised in *Scilla* and fifteen in *Ledebouria*. A full treatment of synonyms is given and notes on distribution and affinities of each species supplement the brief descriptions (of *Ledebouria* spp. only). Fourteen new combinations are effected and two new species, *L. luteola* and *L. viscosa*, described.

### UITTREKSEL

STUDIES VAN DIE BOLDRAENDE LILIACEAE: 1. *SCILLA*, *SCHIZOCARPUS* EN *LEDEBOURIA*. Sitologiese, anatomiese en kromatografiese werk aan die geslag *Scilla* sensu lato in Suid-Afrika word bespreek. Getuienis oor die beste generiese groepering van die soorte word bespreek en 'n sleutel word voorsien vir die twee geslagte, *Scilla* en *Ledebouria*, wat erken word. Vier soorte word in *Scilla* erken en vyftien in *Ledebouria*. Sinonieme word ten volle behandel en aantekeninge oor die verspreiding en verwantskappe van elke soort vul die kort beskrywings vir elke soort aan (slegs *Ledebouria* soorte). Veertien nuwe kombinasies word gemaak en twee nuwe soorte, *L. luteola* en *L. viscosa*, beskryf.

### INTRODUCTION

In 1781, C. Linnaeus the younger, described *Hyacinthus revolutus* from the Cape of Good Hope, basing it on a specimen collected by C. P. Thunberg. Other related species were subsequently described by Thunberg, Jacquin and others under a range of generic names including *Lachenalia* and *Drimia*. It was not until 1820 that a South African species was placed in the genus *Scilla*, a genus originally described by Linnaeus Senior, for several northern hemisphere species. Then, in the second half of the nineteenth century, J. G. Baker transferred *Hyacinthus revolutus* and several species, previously placed in other genera, to *Scilla*. He contributed nearly seventy species, either new or by new combinations, to the list of South African species placed in *Scilla*.

Towards the middle of the present century, F. Z. van der Merwe did much to build up the herbarium record of the genus *Scilla* in its wider sense, describing new species and working on the generic concepts. He recognised three genera

within *Scilla*, as had been recognised by, for example, Baker. Most of the species he retained in his concept of *Scilla*, but he described (1943) a new genus for a small group in which the tops of the bulbs are fibrous. This he called *Schizocarphus*. He also described (1946) a new genus *Resnova* for a small group, which the present author considers to have significant similarities with *Drimiopsis* Lindl. and to differ from the other species of *Scilla* on both floral and vegetative characters. E. P. Phillips, in his "Genera of South African Flowering Plants," 1951, preferred to include *Resnova* and *Schizocarphus* within *Scilla*.

In 1821, Roth described *Ledebouria hyacinthina* from India. No further species have been described under this generic name and this species was transferred to *Scilla* by Baker in 1870. However, in the *Flora Capensis*, Baker retained the name *Ledebouria* for the largest section of *Scilla* in South Africa.

Generic concepts have continued to give trouble, leading to numerous changes in combinations throughout the taxonomic history of this group. Furthermore, the species concepts are also considered by the present author to be the source of considerable nomenclatural and taxonomic confusion. At present, over one hundred valid combinations exist in *Scilla* in South Africa, yet few of these names are applied with any certainty in practice. The present treatment approaches the problem with a very different species concept from that of the earlier treatments. It may be that the "lumping" involved has been too drastic, but in order to establish a stronger foundation on which to build, it is believed that this is necessary at this stage. It is hoped that further long-term studies will show that the complexes recognised here provide a practical subdivision of the genus in its widest context, providing basic units on which to conduct detailed investigations. While the author does not, in several cases, believe that these units will prove to be entirely compatible with a satisfactory species concept, it is hoped that use of the binomials for these complexes will provide a nomenclature which will be useful as an interim classification.

#### ACKNOWLEDGEMENTS

Mrs A. A. Mauve's knowledge of the Liliaceae has been invaluable. Her suggestions have often provided leads to ideas and concepts adopted in this treatment. Students at Rhodes University, Grahamstown, have assisted with much of the experimental work. Mr M. S. Caulton investigated leaf anatomy, Mr K. Easton worked on developing a chromatographic technique, Miss M. M. Gebbie and Miss B. Staker investigated the bulb morphology, Sister M. Hausmann and Miss L. Smook studied the cytology and Sister Hausmann also worked on seedling development. Without their assistance, these aspects would have been greatly curtailed. Col. R. D. A. Bayliss and Mr R. G. Strey have assisted considerably with building up a collection of living material.

The curators of the Albany Museum, Bolus, Botanical Research Institute

(Pretoria), Compton, Kew, Natal and University of Natal (Pietermaritzburg) herbaria have provided facilities for working on their collections. The C.S.I.R. assisted with the costs of a seven week study/collecting trip undertaken during summer 1969/70.

#### GENERIC CONCEPTS

The species of *Resnova* sensu Van der Merwe are not included in this discussion. It is intended to deal with this group together with *Drimiopsis* in the near future.

Living material of the other main groups within *Scilla* sensu Phillips was available, and has been examined in several ways. Unfortunately, neither the time nor material has been available to make a thorough examination of features other than those purely morphological ones which can be determined from herbarium material.

Three main groups are recognised within this generic complex by the present author. These are provisionally termed *Scilla*, *Ledebouria* and *Schizocarpus*,

TABLE 1.—Comparison of the significant morphological features of *Scilla*, *Schizocarpus* and *Ledebouria*.

<i>Scilla</i>	<i>Schizocarpus</i>	<i>Ledebouria</i>
Bulb scales without fibres at apex	Bulb scales with fibres at apex	Bulb scales without fibres at apex
Leaves uniformly green	Leaves uniformly green or with a pink or reddish colouring towards the base	Leaves often conspicuously spotted
Inflorescence terminal	Inflorescence terminal	Inflorescence axillary
Inflorescence erect and rigid	Inflorescence erect and rigid	Inflorescence usually flexuose and softer
Perianth segments blue or rarely pink or white	Perianth segments $\pm$ white	Perianth segments often pink, or white strongly marked with green
Filaments united towards the base	Filaments united towards the base	Filaments free of one another
Ovary oblong	Ovary oblong	Ovary conical, expanding to a wide base below which it contracts very abruptly to the distinct pedicel
Ovules axile, several (rarely 2) in each locule	Ovules axile, several in each locule	Ovules basal, paired in each locule

which are the earliest valid generic names which could be applied to these groups should it be considered advisable to recognise them as distinct genera.

*Morphology:* Table 1 summarises the important points of comparison between the members of the three groups.

The morphology of the bulb apex has been investigated for several species. In species of *Scilla* and *Schizocarpus* the inflorescence appears to arise apically and is usually solitary. In most species of *Ledebouria* the inflorescence appears axillary, and there are usually 2 or 3 per bulb. To determine the origin of the inflorescence, serial longitudinal sections were cut through the apex of bulbs. These sections can be interpreted as supporting this apparent difference, and

TABLE 2.—Published data on chromosomes of South African species of *Scilla* sensu lato and unpublished records by the present author. (Voucher specimens for unpublished records are preserved in the herbarium of the Botany Department, Rhodes University.)

Species	Number	Size Range	Author
Scilla group:— <i>S. firmifolia</i>	2n:18	1·2—4·3 $\mu$ , estimated from drawing	De Wet
<i>S. firmifolia</i> (origin unknown, Rhodes Botany Dept. Garden No. 83)	2n:18	2—10 $\mu$	Jessop and Hausmann (ined.)
<i>S. natalensis</i>	2n:32		De Wet
Schizocarpus group:— <i>S. nervosa</i> (gerrardii form) (Grahamstown, Jessop 885)	2n:42	1—10 $\mu$	Jessop and Hausmann (ined.)
<i>S. nervosa</i>	2n:28, 56	1·2—2·5 $\mu$ , estimated from drawing	De Wet
Ledebouria group:— <i>L. apertiflora</i> (= <i>S. linearifolia</i> )	2n:24		Fernandes & Neves
<i>L. cooperi</i> (Peddie, Bayliss BS/3226)	n:c.22		Jessop (ined.)
<i>L. cooperi</i> (Port Shepstone, Strey 9291)	n:12, 14	1·7—4·3 $\mu$	Jessop (ined.)
<i>L. floribunda</i> (Grahamstown, Jessop in Rhodes Botany Dept. Garden no. 33)	n:18 or 19	2·4—3·9 $\mu$	Jessop (ined.)
<i>L. revoluta</i> (= <i>S. lanceaefolia</i> ) (Grahamstown, Easton in Rhodes Botany Dept. Garden no. 40)	n:15		Jessop (ined.)
<i>L. revoluta</i> (Grahamstown, Smook s.n.)	not counted	1·1—5·3 $\mu$	Jessop & Smook (ined.)
<i>L. revoluta</i> (20 miles N. of Pretoria, Jessop in Rhodes Botany Dept. Garden no. 135)	n:15		Jessop (ined.)
<i>L. undulata</i> (Graaff Reinet, Bayliss BS/3910)	n:18 or 19	2·4—3·9 $\mu$	Jessop (ined.)
<i>L. undulata</i> (Swaziland, Bayliss BS/3469)	n:18		Jessop (ined.)

indicate that the inflorescence of *Ledebouria* is axillary even in those species where it appears terminal externally. It is, however, doubted whether this method gives absolute certainty as to the origin of the inflorescence.

*Cytology*: Little work has been done on this aspect. Previous work by Kwiton Jong (unpublished thesis, 1961) and De Wet (1957) indicate a wide range in number of chromosomes—even within a single population. All counts except those of Kwiton Jong, which are unpublished, are shown in Table 2.

Although, in several cases, it appears that there is a certain amount of variation in chromosome numbers within material from a single plant, no other evidence of anomalous pairing in meiosis of pollen mother cells was found by the present author.

The distribution of chromosomes in various size groups in the complement of each species suggests that there may be significant characters to be obtained. However, it does not seem that overall numbers or range in size will be of very great value. Further work will be carried out.

*Anatomy*: Anatomical work has been done on the leaf anatomy of five specimens of *Ledebouria*, three of *Schizocarpus*, and three of *Scilla*. This covers all South African species, recognised by the present author, of the latter two groups and a representative sample of the former one. The species of *Ledebouria* appear to differ from the others in the possession of a palisade layer and in lacking a lignified bundle cap. However, no bundle cap was found in *S. plumbea* (*Scilla*). In these aspects, *S. plumbea* is similar to two northern hemisphere species of *Scilla* sensu lato, examined (i.e. *S. peruviana* and *Endymion non-scriptus*). It seems possible that the presence or absence of a palisade layer, but not the bundle cap, may prove to be of value.

*Chromatography*: Following the methods used in other groups (c.f. Riley and Bryant, 1961, and Riley and Isbell, 1963) a simple paper chromatography was employed. Two solvents were tried on both methanol extracts and on smears. Para-anisidine hydrochloride and ultra violet light were used to characterise the spots. However, the spots were not sufficiently well distinguished either on position or colour, and the results of comparisons between members of this generic complex and other apparently less closely related genera proved very confusing.

*Germination stages*: Study of the early germination stages of a specimen of *S. nervosa* (*Schizocarpus*) and of *S. firmifolia* (*Scilla*) suggests considerable differences between these species. Chouard (1930), however, showed that both patterns occur in several genera of the Liliaceae. It does not appear that these

patterns, which he called "épigé" and "hypogé", show any relation to generic concepts in the Scilleae. This does not preclude the possibility that the apparent anomalies are a result of faulty concepts rather than with non-correlation between germination stages and affinity.

*Summary of generic characters:* The origin of the inflorescence, the leaf anatomy, the fusion of the basal parts of the filaments, the shape of the ovary and arrangement of the ovules suggest very much closer affinities between the species of *Scilla* and *Schizocarpus* than between either of these groups and *Ledebouria*. Only on the fragmentary cytological evidence, the germination stages, and on the fibrous apex to the bulb-scales could *Schizocarpus* be separated as a distinct genus at this stage. It is felt that without further evidence these characters do not provide satisfactory criteria for maintaining *Schizocarpus* as a distinct genus and it is, therefore, not recognised as such in this treatment. On the other hand it is thought possible that further data may not justify this attitude. *Ledebouria* must be accepted as not only generically distinct, but possibly not even belonging to a particularly closely allied group within the Scilleae.

#### SPECIES CONCEPTS

It has been found that the members of a population do not vary greatly from one another except in size. Two examples, based on rather small samples, illustrate the variation encountered in very restricted areas (see fig. 1). In both cases there is a fairly wide spread of sizes and proportions of the leaves.

In the Scilleae there are very few qualitative characters that could be used in taxonomic work. The distribution and form of spotting or marking of the leaves have been found to be extremely inconsistent in almost all populations. Similarly, whether the leaves are erect or prostrate is greatly influenced by both the time of year in relation to flowering and climate and the height and density of the surrounding vegetation.

Floral characters are of great value in delimiting genera, but there is often very little variation in floral structure within these genera.

It has been found that whether a broad or narrow concept of the species limits is taken, intermediates between even the largest and smallest forms of the genera treated here occur. There are very few species of *Ledebouria* which are defined on really satisfactory qualitative characters. These are *L. hypoxidioides*, *L. viscosa*, *L. ovatifolia* and perhaps *L. luteola*. The remainder are based on less well-defined characters and most show very considerable amounts of variation. In *Scilla*, *S. plumbea* and *S. firmifolia* are well-defined, but the other two species recognised each include wide ranges of forms.

One possible explanation for the difficulty in defining species in these genera may be a predominance of non-sexual reproduction, particularly apomixis.

Apomictic groups are notoriously difficult to describe in terms of conventional taxonomy. It would be very helpful to know to what extent, if any, apomixis occurs in the Scilleae. The possibility seems to be supported by the rarity of fruits, especially in *Ledebouria*. Even in hand-pollinated flowers seeds are frequently not produced. The evidence, although scant as yet, seems to support, rather than oppose, the presence of chromosomal abnormalities, as shown by meiotic numbers.

In eight plants examined by the present author, by the method of Alexander (1969), one showed 60% sterility of pollen, but half the plants showed less than 10% sterility. Little or no success has been had with the germination of pollen on cellophane using the method found satisfactory by Wilsenach and Papenfus (1967). The occasional presence of aborted flower buds on otherwise normal inflorescences (especially frequent towards the base) may indicate abnormalities in floral morphogenesis, which might possibly also extend to the sexual parts of apparently normal flowers.

On the other hand no evidence of anomalous meiotic pairing of chromosomes has been found in the limited pollen mother cell material of seven plants, examined by the author.

No conclusion as to the presence or absence of apomixis can, therefore, be reached at this point.

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WILSENACH, R. and PAPENFUS, J. N. 1967. Cytological observations on *Hypoxis*: II Pollen germination, pollen tube growth and haploid chromosome numbers in some *Hypoxis* species. *Jl S. Afr. Bot.* 33: 111-116.

### Key to the genera

A key to the genera described in this paper and the second paper in this series will be included in the next paper.

### SCILLA L.

Sp. Pl.: 308 (1753).

*Scilla* sensu Bak. in Fl. Cap. 6: 478 (1896), partly; sensu Phill., Gen. S. Afr. Flower, Pl.: 191 (1951), partly. *Schizocarpus* Van der Merwe in Flower. Pl. S. Afr. 23: t.904 (1943). Type species: *S. nervosus* (Burch.) Van der Merwe.

*Bulbs* present, sometimes fibrous towards the top. *Leaves* all basal, sometimes with reddish markings towards the base, but not spotted. *Inflorescence* erect, originating from the apical bud of the bulb, rarely branched. *Bracts* single or paired, not spurred. *Perianth* segments similar or almost so, usually spreading. *Filaments* connate towards the base. *Ovary* oblong, usually with more than 2 ovules per locule. *Ovules* axile.

Type: *S. bifolia* L., from Europe.

The affinities of *Scilla* with South African genera other than *Ledebouria*, *Resnova* and *Drimiopsis* has not been fully investigated. It is worth mentioning *Pseudogaltonia* in which the bulb has fibres similar to those characterising *S. nervosa* and which has the floral characters of *Scilla* except that the perianth is zygomorphic.

Descriptions of the species have not been included as the important features appear in the key.

### KEY OF SPECIES OF SCILLA IN SOUTH AFRICA

Perianth a vivid blue or purplish blue.

Perianth segments ascending. Leaves linear to lanceolate. Restricted to the south-western Cape . . . . . 1. *plumbea*

Perianth segments spreading. Leaves lanceolate to ovate. Eastern Cape through Natal to the eastern Transvaal . . . . . 2. *natalensis*

Perianth white, greenish or pink.

Bulbs without fibrous tops. Inflorescence sometimes branched. Leaves usually less than 125 mm long. Restricted to the Alicedale, Bathurst, Peddie area . . . . . 3. *firmifolia*

Bulbs with fibrous tops. Inflorescence always simple. Leaves usually more than 125 mm long. Widespread . . . . . 4. *nervosa*

1. *Scilla plumbea* Lindl. in Bot. Reg. 16: t.1355 (1830). Type: Bot. Reg. 16: t.1355 (1830); figured from a plant in cultivation in England.



*Scilla ?natalensis*, pro parte, sensu Bak. in Fl. Cap. 6: 482 (1896).

Restricted to the south-western Cape in the vicinity of Bain's Kloof.

For illustration and discussion of typification, see Lewis, G. J. in *Flower. Pl. Afr.* 26: t.1006 (1947).

*Selected specimens:*

CAPE—3319 (Worcester): Bain's Kloof mountains, *Van Breda* 907 (NBG, PRE); Baviaans Kloof, *Linley* s.n. in SAM 56004 (BOL, NBG, PRE, SAM); without locality, *Drège* 1997 (G).

2. *Scilla natalensis* Planch. in Flore des Serres: t.1043 (1855). Type: Flore des Serres: t.1043 (1855). *Scilla kraussii* Bak. in J. Linn. Soc. (Bot.) 13: 243 (1873). Type: "Natalia", *Krauss* 444 (K, lecto.; PRE, photo.), without locality, *Gerrard* 740.

Occurs in the eastern Cape as far west as Kentani, Lesotho, Natal, Swaziland, eastern O.F.S., and Transvaal mainly along the escarpment.

In the south of its range the leaves of the larger plants (peduncles more than 300 mm long) are glabrous, but in the Transvaal they are almost always pubescent. The smaller plants (peduncles less than 350 mm long) are restricted to the southern part of this species range and are pubescent. On *Rogers* 12507 (BOL) is a note that in the Tzaneen area, although usually pubescent, the leaves are glabrous in plants growing in a vlei or a garden.

It has been extremely difficult to decide whether or not to give the larger and smaller forms taxonomic recognition. In view of the evidence that pubescence may be not entirely a genetically determined phenomenon and in view of the range in size of the pubescent-leaved plants only a single taxon is recognised here. Populations examined by the author near Kamberg and the Oliviershoek Pass (Natal) and near Tzaneen exhibited such a range in size of plant and pubescence that it did not appear likely that any subdivision of this complex would serve any useful purpose.

*Selected specimens:*

TRANSSVAAL—2531 (Komatipoort): Barberton, *Galpin* 619 (BOL, PRE).

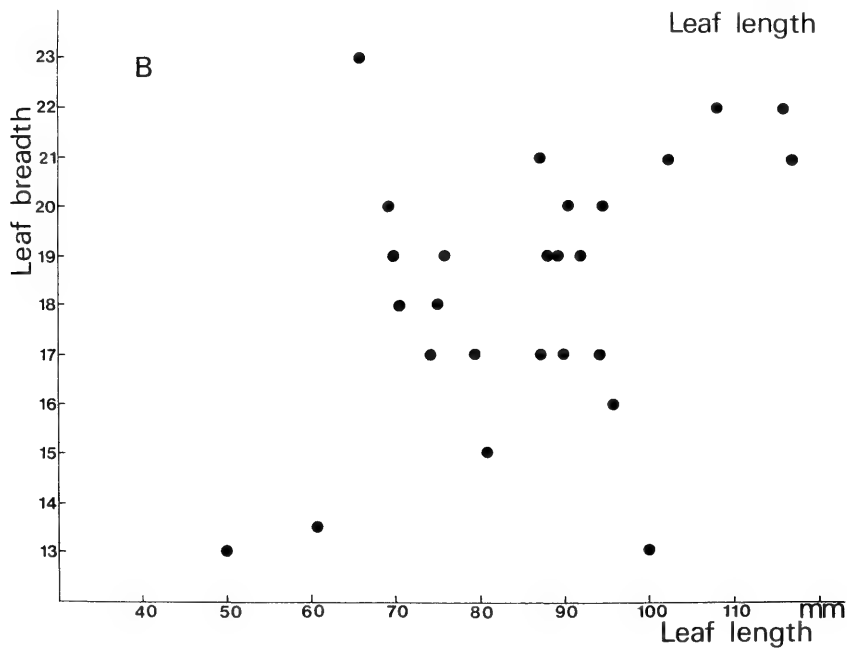
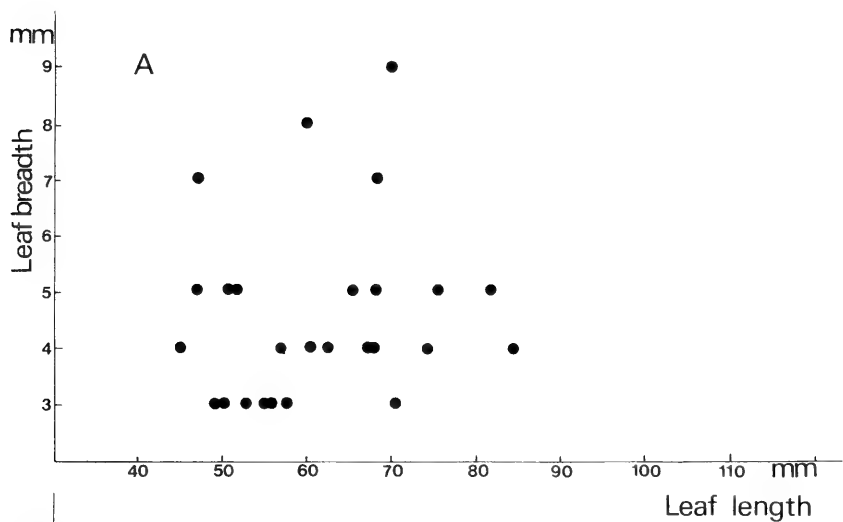
LESOTHO—2828 (Bethlehem): Leribe, *Dieterlen* 416 (PRE).

NATAL—2930 (Pietermaritzburg): near York, *Wood* 4304 (BOL, NH, PRE).

CAPE—Pondoland without precise locality, *Bachmann* 286 (Z).

3. *Scilla firmifolia* Bak. in Saund., Ref. Bot. 3, app.: 7 (1870). Type: "Cape of Good Hope", *MacOwan* 461 (K, lecto., PRE, photo.!, GRA!; PRE!), "Eastern frontier", *Drège* 4492 (K; PRE, photo.!).

Restricted to a small part of the eastern Cape from Bathurst to Peddie and inland as far as Alicedale.



This is the only species of *Scilla* in South Africa in which the inflorescence is sometimes branched.

For illustration, see Van der Merwe, F. Z. in *Flower. Pl. Afr.* **24**: t.926 (1944).

*Selected specimens:*

CAPE—3326 (Grahamstown): Grahamstown, *Rogers 30104* (Z); 3327 (Peddie):  $\frac{1}{2}$  mile south of Kaffir Drift, *Dyer 3374* (NH, PRE); Line Drift, *Sim 4060* (PRE).

**4. *Scilla nervosa* (Burch.) Jess., comb. nov.**

*Ornithogalum nervosum* Burch., *Trav.* **1**: 537 (1822). *Type*: Cape, "between Griquatown and Witte Water", *Burchell* 1968 (K, holo.; PRE, photo.!).

*Schizocarpus nervosus* (Burch.) Van der Merwe in *Flower. Pl. S. Afr.* **23**: t.904 (1943).

*Scilla rigidifolia* Kunth, *Enum. Pl.* **4**: 330 (1843). *Type*: Cape, *Drège* 4560b (K; PRE, photo.!).

*Schizocarpus rigidifolius* (Kunth) Van der Merwe in *Flower. Pl. S. Afr.* **23**: t.905 (1943).

*Scilla pallidiflora* Bak. in *Saund., Ref. Bot.* **3**: t.179 (1870). *Type*: Saund., *Ref. Bot.* **3**: t.179 (1870).

*Scilla versicolor* Bak. in *Saund., Ref. Bot.* **5**: t.305 (1873). *Type*: Saund., *Ref. Bot.* **5**: t.305 (1873).

*Scilla gerrardii* Bak. in *J. Linn. Soc. (Bot.)* **13**: 237 (1873). *Type*: "Natalia", *Gerrard* 1829 (K, lecto.; PRE, photo.!), "Kaffraria", *Hutton* s.n.

*Schizocarpus gerrardii* (Bak.) Van der Merwe in *Flower. Pl. S. Afr.* **23**: t.906 (1943).

*Scilla pubescens*<sup>s</sup> Bak. in *Bull. Herb. Boissier*, ser. 2, **1**: 853 (1901). *Type*: Natal, near Howick, *Schlechter* 6799 (Z!).

*Schizocarpus acerosus* Van der Merwe in *Flower. Pl. S. Afr.* **23**: t.904 (1943.) *Type*: Transvaal, Middelburg, Elandspruit, *Van der Merwe* 2236 (PRE!).

Occurs throughout the eastern Cape from Alexandria eastward through Lesotho and Natal into the northern Cape, O.F.S., Swaziland, Transvaal and Botswana as far north as Angola and Tanzania.

Attempts at subdividing the complex on the basis of leaf measurements, as used by Van der Merwe, have not been found useful; see fig. 2.

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FIG. 1.—Diagrams to illustrate variation in leaf size in small natural populations.

A. *Scilla nervosa*. Population area—80 sq. metres. 15 miles S.E. of Kamberg on road to Nottingham Road (2929; Underberg, Natal).

B. *Ledebouria marginata*. Population area—2,000 sq. metres. 12 miles north of Cathcart (3227; Stutterheim, Cape).

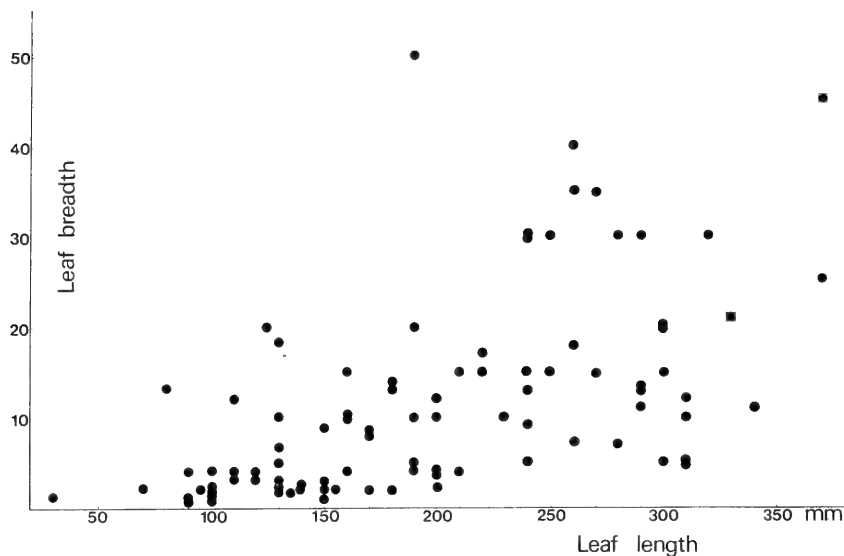


FIG. 2.—Diagram to illustrate variation in leaf size in *Scilla nervosa*; based on herbarium specimens.

*Selected specimens:*

S.W.A.—1720 (Sambio): 3 miles east of Masari Camp, *De Winter 4103* (PRE).

TRANSVAAL—2430 (Pilgrim's Rest): Wolkberg, *Gerstner 5606* (PRE).

BOTSWANA—2525 (Mafeking): Lobatsi, *Rogers 30480* (Z).

NATAL—2829 (Harrismith): Van Reenen, *Wood 12173* (PRE).

O.F.S.—2926 (Bloemfontein): Bloemfontein, *Bolus 10824* (BOL, PRE).

LESOTHO—2927 (Maseru): "Mafeteng district", *Dieterlen 1312* (PRE).

CAPE—3228 (Butterworth): Kentani, *Pegler 362* (PRE).

LEDEBOURIA ROTH

*Novae plantarum species* (1821).

*Scilla* sensu Bak. in *Fl. Cap.* 6: 478 (1896), partly; sensu Phill., *Gen. S. Afr. Flower*, Pl.: 191 (1951), partly.

*Bulbs* present, never fibrous towards the top. *Leaves* all basal, often with reddish or green spots or markings, especially on the upper surface. *Inflorescence* usually cernuous, axillary in origin, always simple. *Bracts* poorly developed, single or paired, not spurred. *Perianth segments* reflexed to ascending. *Filaments* free of one another. *Ovary* conical, expanding to a wide base below which it contracts abruptly, with two ovules per locule. *Ovules* basal.

Type: *L. hyacinthina* Roth (= *S. indica* Bak.), from India. (For figure, see Curtis's bot. Mag. 60: t.3226; 1833.)

KEY TO SPECIES OF LEDEBOURIA IN SOUTH AFRICA

1. Bulb small, less than 25 mm long, or if longer then less than one sixth of the length of the longest leaves at flowering, very rarely with any pink colour, often with only one membranous outer bulb scale. Leaves usually rather soft; the lamina of the outermost often greatly reduced or absent. Flowers and pedicels often uniformly pink.
  2. Bulb above ground, very rarely over 20 mm long. Leaves often with a silvery colour on the upper surface. Eastern Cape . . . . . 4. *socialis*
  2. Bulb usually below ground. Leaves probably never with a silvery colour on the upper surface. Wide-spread.
    3. Bulb more than 40 mm long, with numerous tightly arranged scales . . . . . 6. *apertiflora*
    3. Bulb 25—40 mm long, with fewer, relatively loosely arranged scales . . . . . 2. *cooperi*
    3. Bulb less than 25 mm long, with few or many loosely or tightly arranged scales.
      4. Bulb with several dry outer scales which often form a neck. Leaves more or less erect, not considerably narrowed to the base. Inflorescence variable. Flowers pink-striped, greenish or greyish. Mainly in dry areas . . . . . 9. *undulata*
      4. Bulb with several dry outer scales, never forming a neck. Leaves more or less spreading, narrowing considerably to the base. Inflorescence lax. Flowers pink-striped. Southern Cape west of Knysna . . . . . 1. *ovalifolia*
      4. Bulb with very few (usually not more than 2 or 3) or no dry outer scales, which never form a neck. Leaves variable in shape. Inflorescence usually very compact. Flowers often uniformly pink. Wide-spread east of Knysna . . . . . 2. *cooperi*
1. Bulb generally at least 30 mm long and more than one sixth of the length of the longest leaves at flowering, sometimes partly pink usually with several membranous outer bulb scales. Leaves firmer; the lamina of the outermost not appreciably smaller than the others. Flowers either greenish, greyish or with pink markings, but probably never uniformly pink.
  5. Leaves viscid. Kransberg, Thabazimbi area of the Transvaal . . . . . 15. *viscosa*
  5. Leaves densely hairy. Grahamstown . . . . . 14. *hypoxidioides*
  5. Leaves neither viscid nor hairy.
    6. Bulb scales of very different heights, all relatively firm, producing copious threads when torn. Leaves, at least towards the end of the flowering season, usually ovate and appressed to the ground . . . . . 13. *ovatifolia*
    6. Bulb scales all reaching approximately the same height at the top of the bulb, the outermost forming dry tunics, producing thread, when torn, in only one species. Leaves usually erect or erect-spreading and ovate to linear.
      7. Bulb scales usually yellow especially when dried, except for the few membranous outer ones, longitudinally ridged and producing copious threads when torn—these threads usually showing even on herbarium material . . . . . 12. *luteola*
      7. Bulb scales not as above.
        8. Leaves over 150 mm long; usually much longer than the bulb at flowering.
          9. Bulbs over 70 mm long. Flowers usually more than 150 per inflorescence . . . . . 3. *floribunda*
          9. Bulbs less than 70 mm long. Flowers usually fewer than 150 per inflorescence.
            10. Leaves linear or narrowly linear-lanceolate, long attenuate, usually over 200 mm long, and less than 20 [–25] mm broad . . . . . 6. *apertiflora*
            10. Leaves lanceolate to oblong-lanceolate, usually not very attenuate, and broadest near the middle, usually under 220 mm long, and more than 25 mm broad . . . . . 7. *revoluta*
        8. Leaves less than 150 mm long, often shorter than the bulb at flowering.
          11. Leaves shorter than the bulb at flowering, or if longer then lanceolate to ovate and more than 10 mm broad.

12. Leaves very glaucous, erect, not very firm. Bulb tunics partly dark and shiny and usually with a pinkish wash . . . 8. *inquinata*
12. Leaves not very glaucous, erect or spreading, variable in texture. Bulb tunics with or without dark shiny areas, but pink colour, when produced, generally in the form of speckling.
13. Leaves rather firm so that they retain their shape on the plant for several months after they have dried out, rather long attenuate in the distal half and usually spirally twisted . . . 11. *marginata*
13. Leaves softer, wrinkling and disintegrating rapidly after their death, not as strongly attenuate or spirally twisted.
14. Bulb largely above ground. Leaves erect, usually undulate and uniformly green. Eastern Cape . . . 5. *concolor*
14. Bulb below ground. Leaves erect-spreading to spreading, not undulate, usually spotted. Wide-spread . . . 7. *revoluta*
11. Leaves usually longer than the bulb at flowering, often linear to linear-lanceolate and less than 10 mm broad.
15. Leaves more than 200 mm long, linear or narrowly linear-lanceolate . . . 6. *apertiflora*
15. Leaves less than 150 mm long, lanceolate to linear.
16. Leaves usually 10 or more, usually twisted, less than 5 mm broad . . . 10. *graminifolia*
16. Leaves usually fewer than 10, often 5—10 mm broad. . . 9. *undulata*

1. **Ledebouria ovalifolia** (Schrad.) Jess., comb. nov. *Drimia ovalifolia* Schrad., Blumenb.: 28 (1827). Type: Lodd. Bot. Cab.: 278, sub *Drimia lanceaeifolia*, (1818).

*Scilla ovalifolia* (Schrad.) C.A.Sm. in Kew Bull. 1930: 245 (1930).

*Lachenalia reflexa* Andr. Bot. Rep. 5: t.299 (1803), nom. illegit., non Thunb.

*Drimia gawleri* Schrad., Blumenb.: 30 (1827). Type: Curtis's bot. Mag. 33: t.1380, sub *Drimia lanceaeifolia* ( $\beta$ ), (1811).

*Drimia lanceolata* Schrad., Blumenb.: 28 (1827). Type: Andr. Bot. Rep. 5: t.299, sub *Lachenalia reflexa* (1803).

*Scilla lanceolata* (Schrad.) Bak. in Saund., Ref. Bot. 3, app.: 14 (1870).

*Scilla revoluta* (L.f.) Bak. sensu Bak. in Fl. Cap. 6: 485 (1896), non L.f.

*Scilla genadendalensis* Von Poelln. in Port. Acta biol., ser. B, 1: 212 (1945). Type: Cape, Genadendal, *Schlechter* 10327 (BOL!, GRA!, PRE!, Z!).

*Scilla doratophylla* C.A.Sm. in Kew Bull. 1930: 245 (1930). Type: as for *Drimia lanceolata* Schrad.

*Bulbs* 15—25 mm long. *Leaves* 3—5, 15—35 mm long, 6—11 mm broad, spreading or somewhat erect-spreading, with a distinctly petiole-like base; the sides of the leaf towards the base usually turned up, forming a gutterlike shape, the sides folding in in dried material. *Inflorescence* 60—90 mm long with a rather lax arrangement of the spreading pedicels. *Flowers* usually fewer than 20, "dull red".

Has been collected from Bot River, in the west, to Plettenberg Bay in the

east; being restricted to the coastal belt, although occurring as far inland as Bonnievale. Records suggest a preference for rocky habitats.

In the east of its range it merges with the smaller forms of *L. cooperi*. The leaf-form does not always provide adequate grounds for separation, but the laxer inflorescence in *L. ovalifolia* can generally be regarded as diagnostic. Confusion with *L. revoluta* is also possible, but the shape of the base of the leaf, the smaller bulb and form of the inflorescence provide characters for separation.

*Selected specimens:*

CAPE—3419 (Caledon): Bot River valley, *Guthrie 2321* (BOL); 3420 (Bredasdorp): De Hoop, *Barker 8744* (NBG); 3423 (Knysna): Plettenberg Bay, *Newdigate* s.n. in Herb Duthie 1207 (BOL).

2. *Ledebouria cooperi* (Hook.f.) Jess., comb. nov.

*Scilla cooperi* Hook.f. in Curtis's bot. Mag. **92**: t.5580 (1866). *Type*: Cape, *Cooper* s.n. (K, holo.; PRE, photo.!).

*Scilla subglauca* Bak. in Saund. Ref. Bot. **3**: t.186 (1870). *Type*: Saund., Ref. Bot. **3**: t.186, "Cape of Good Hope, *Cooper*", (1870).

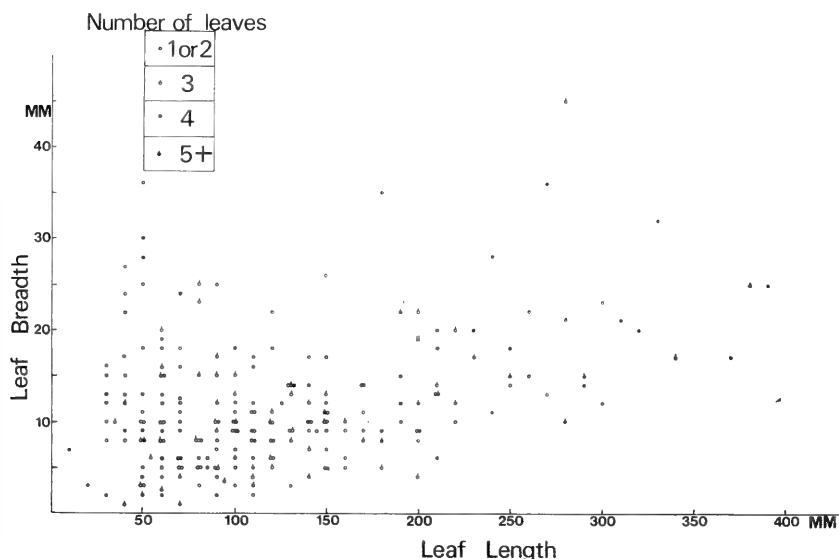


FIG. 3.—Diagram to illustrate variation in leaf size and number in the *Ledebouria cooperi* complex; based on herbarium specimens.

- Scilla sandersonii* Bak. in Saund., Ref. Bot. 3, app.: 5 (1870). *Type*: Transvaal, Sanderson s.n. (K, holo.; PRE, photo.!).
- Scilla minima* Bak. in Saund., Ref. Bot. 3, app.: 6 (1870). *Type*: Transvaal, Magaliesberg, Burke s.n. (K, holo.; PRE, photo.!.; BOL, drawing!).
- Scilla concinna* Bak. in Saund., Ref. Bot. 4: t.235 (1870). *Type*: Saund., Ref. Bot. 4: t.235, "Cape Colony, Cooper", (1870).
- Scilla saturata* Bak. in J. Bot., Lond. 1874: 365 (1874). *Type*: Orange Free State, Cooper 993 (K, holo.; PRE, photo.!).
- Scilla macowanii* Bak. in Gdnrs' Chron. 3: 748 (1875). *Type*: Cape, "Somerset Division", Boschberg, MacOwan 1841 (BOL!; GRA!, PRE, photo.!.; Z!).
- Scilla pusilla* Bak. in J. Bot., Lond. 1876: 183 (1876). *Type*: Cape, Bazeia, Baur 293 (K, holo.; PRE, photo.!.; BOL, drawing!.; SAM!).
- Scilla adlamii* Bak. in Gdnrs' Chron. 9: 521 (1891). *Type*: Natal, Adlam s.n. (K, holo.; PRE, photo.!.; BOL, drawing!).
- Scilla leptophylla* Bak. in Fl. Cap. 6: 483 (1896). *Type*: Transvaal, "near the Devil's Kantoor", Bolus 7623 (K, holo.; BOL, drawing! and iso.!).
- Scilla tysonii* Bak. in Fl. Cap. 6: 484 (1896). *Type*: Cape, "Griqualand East", Tyson s.n. (K, holo.; BOL & GRA, drawings!).
- ?*Scilla sphaerocephala* Bak. in Fl. Cap. 6: 484 (1896). *Type*: Cape, Little Namaqualand, Bolus s.n. (Type not seen, determination from description. There appears to be no specimen at Kew or the Bolus Herbarium, but the description fits this concept of *L. cooperi* in every aspect—only the locality being out of the typical range.)
- Scilla inandensis* Bak. in Fl. Cap. 6: 483 (1896). *Type*: Natal, Inanda, Wood 630 (BOL!; NH!; SAM!); "near Tongaat River", Saunders s.n.
- Scilla globosa* Bak. in Fl. Cap. 6: 484 (1896). *Type*: Cape, near Kokstad, Tyson s.n. (?Tyson 1557 in BOL! and SAM!).
- Scilla baurii* Bak. in Fl. Cap. 6: 484 (1896). *Type*: Cape, "Tembuland, Bazeia Mountain", Baur 550 (K, holo.; PRE, photo.!.; SAM!).
- Scilla rogersii* Bak. in Fl. Cap. 6: 484: (1896). *Type*: South Africa, Rogers s.n. (K, holo.; PRE, photo.!).
- Scilla leichtlinii* Bak. in Fl. Cap. 6: 486 (1896). *Type*: South Africa ex hort. Leichtlin (K, holo.; PRE, photo.!.; BOL, drawing!).
- Scilla galpinii* Bak. in Fl. Cap. 6: 487 (1896). *Type*: Transvaal, "summit of Devil's Kantoor", Galpin 672 (BOL!; GRA!; NH!, PRE, photo.!.; PRE!; SAM!; Z!).
- Scilla oostachys* Bak. in Fl. Cap. 6: 487 (1896). *Type*: Natal, "upper Umkomaas", Wood 4627 (K; BOL, drawing!); NH!, PRE, photo.!).
- Scilla diphylla* Bak. in Fl. Cap. 6: 489 (1896). *Type*: Transvaal, "Saddleback range near Barberton", Galpin 1182 (K, holo.; TRE, photo.!.; BOL, drawing!; BOL!; GRA!; NH!; PRE!; SAM!).



*Scilla palustris* Wood & Evans in J. Bot., Lond. 1899: 251 (1899). *Type*: Natal, Newcastle, Wood 6501 (NH, holo.!; PRE, photo.!).

*Scilla rehmannii* Bak. in Bull. Herb. Boissier, ser. 2, 1: 853 (1901). *Type*: Natal, Inanda, Rehmann 8277 (Z!).

*Scilla fehrii* Bak. in Bull. Herb. Boissier, ser. 2, 1: 788 (1901). *Type*: Transvaal, Pretoria, Fehr s.n. (Z!).

*Scilla aggregata* Bak. in Bull. Herb. Boissier, ser. 2, 4: 1001 (1904). *Type*: Transvaal, Modderfontein, Conrath 701 (K, holo.; PRE, photo.!; GRAZ; PRE, photo.!).

*Scilla tristachya* Bak. in Bull. Herb. Boissier, ser. 2, 4: 1001 (1904). *Type*: Transvaal, Modderfontein, Conrath 693 (GRAZ; PRE, photo.!; BOL, drawing!; Z!).

*Scilla londonensis* Bak. in Bull. Herb. Boissier, ser. 2, 4: 1002 (1904). *Type*: Cape, East London, Conrath 694 (GRAZ; PRE, photo.!).

*Scilla conrathii* Bak. in Bull. Herb. Boissier, ser. 2, 4: 1002 (1904). *Type*: Transvaal, Modderfontein, Conrath 132 (GRAZ; PRE, photo.!; K; PRE, photo.!).

*Scilla lepida* N.E.Br. in Kew Bull. 1921: 299 (1921). *Type*: Transvaal, Palala River, Breyer s.n. in Herb. Rogers 24009 (K, holo.; PRE, photo.!; BOL, drawing!; PRE!).

*Scilla bella* Markotter in Annale Univ. Stellenbosch, reeks A, 8, afl. 1: 13 (1930). *Type*: Natal, Oliviershoekpas, Thode s.n. in STE 3372 (STE, holo.; PRE, photo.!).

*Scilla cinerascens* Van der Merwe in Flower. Pl. S. Afr. 21: t.827 (1941). *Type*: Transvaal, Piet Retief, Wolwekop, Van der Merwe 1119 (PRE, holo.!).

*Scilla rupestris* Van der Merwe in Flower. Pl. S. Afr. 21: t.828 (1941). *Type*: Transvaal, Pilgrims Rest near Mac Mac and Sabie, Van der Merwe 1586 (PRE, holo.!).

*Scilla petiolata* Van der Merwe in Flower. Pl. S. Afr. 21: t.832 (1941). *Type*: Transvaal, near Graskop, Strydom s.n. (PRE, holo.!).

*Scilla glaucescens* Van der Merwe in Flower. Pl. S. Afr. 23: t.912 (1943). *Type*: Transvaal, Carolina, Onbekend, Van der Merwe 2073 (PRE, holo.!).

*Bulbs* usually lacking, or with only a few, dark membranous outer scales, usually much shorter than the leaves, generally under 40 mm long. *Leaves* usually 1—3, [10—]30—250[—400] mm long, 1—20[—50] mm broad, erect, soft and slightly fleshy, often narrowing appreciably to the base, oblong, ovate or linear, but rarely attenuate. The outermost leaf often much shorter than the others, entirely clasping the bulb and hardly possessing any green colouring. *Inflorescence* usually more or less erect, usually with fewer than 50 flowers. *Perianth segments* often a rather uniform pink colour, less often green or pink with a green keel.

Wide-spread in South Africa except in the drier western areas and the south-western Cape. Probably rare in South West Africa, but extending northwards into Rhodesia. The type of *S. sphaerocephala* has not been located but was reported to have been collected in Namaqualand. It frequently occurs in dampish areas in the grassveld, but also on slopes and among rocks.

Vegetative reproduction by means of runners has been reported from near Belfast (*Van der Merwe* 1829; PRE).

There is very considerable morphological variation within this concept of *L. cooperi*. A number of series are indicated below. Whether or not these will prove to be worthy of taxonomic recognition has not been determined with any certainty, but it does appear that the degree of overlap between these series is such as to preclude their recognition at specific level. As the present author does not wish to accord these series taxonomic significance, it is suggested that, where it is desired to refer to them, their correct epithets, under *Scilla*, be used to identify them. The following binomials indicate their correct epithets if they were regarded as having specific status.

*Cooperi series*: Leaves linear-lanceolate, 160—300 mm long, about 20 mm broad.

This series merges with *L. apertiflora*, but has a smaller bulb with fewer scales and narrower, apparently softer, leaves and often showing characteristic longitudinal lines of the abaxial surface of the leaves. It also merges with *L. floribunda* but has narrower leaves and fewer-flowered inflorescences. (See Flower. Pl. S. Afr. **24**: t.943; 1944.)

*Saturata series*: A smaller edition of the cooperi series. Leaves up to 100—150 mm long, about 10 mm broad.

It is through this series that a gradation occurs between *L. cooperi* and *L. ovalifolia* of the south-western Cape. However, the inflorescence is generally more compact, and the leaves more strongly erect. (See Flower. Pl. S. Afr. **17**: t.674; 1937.)

*Sandersonii series*: Similar to the saturata series, but smaller and with ovate or lanceolate to almost orbicular leaves, often distinctly petiolate. (See Flower. Pl. S. Afr. **21**: t.832; 1941.)

*Minima series*: Similar to the previous series but with narrowly linear leaves.

*Galpinii series*: Similar to the sandersonii series but with the surface of the leaf pitted.

Probably restricted to the south-eastern Transvaal (Belfast degree block). (See Flower. Pl. S. Afr. **22**: t.864; 1942.)

The difficulty of giving these series, other than the galpinii series which is characterised by an apparently qualitative difference, taxonomic status is illustrated by means of a scatter diagram (fig. 3) in which the three main leaf variables are indicated. Differences in leaf size are largely genetic, but environment as well as the stage of leaf growth in relation to flowering probably add to the difficulty of using quantitative leaf characters in defining taxa in this species complex. The galpinii series differs from the sandersonii series only in the pitting of the leaf. The fact that this is the only difference and some evidence that this is not always clear-cut motivated the retention of this series within *L. cooperi*. The galpinii series appears to be the only one which is limited to only a small part of the range of the species complex as a whole.

Specimens occur linking the *L. cooperi* complex with several other species; in particular *L. ovalifolia*, *L. graminifolia* and *L. undulata*. The smaller bulb, and frequently uniformly pink flowers are useful characters. Although several specimens, placed by the present author in the *L. cooperi* complex, do have green or striped flowers, uniformly pink flowers rarely, if ever, occur in other species or complexes in *Ledebouria*.

*Selected specimens:*

*Cooperi series:*

TRANSVAAL—2528 (Pretoria): Rietvlei, *Repton 3132* (PRE).

LESOTHO—2828 (Bethlehem): Leribe, *Dieterlen 57a* (Z).

CAPE—3227 (Stutterheim): East London, *Ratray s.n.* (GRA); 3326 (Grahamstown): Blaauwkrantz, *Daly 1026* (BOL, GRA, Z).

*Saturata series:*

S.W.A.—1715 (Ondangua): Ondangua, *De Winter & Giess 6852* (PRE).

TRANSVAAL—Vaal River without precise locality, *Wilms 1530a* (G); 2527 (Rustenburg): near Rustenburg, *Pegler 975* (BOL).

SWAZILAND—2531 (Komatipoort): Nottingham Peak, Havelock Concession, *Saltmarsh s.n.* in Herb. *Galpin 1053* (BOL, GRA, PRE).

NATAL—2931 (Stanger): Claremont, *Schlechter 2959* (BOL, GRA, Z), *2959a* (G).

*Sandersonii series:*

TRANSVAAL—2530 (Lydenburg): Dullstroom, *Killick & Strey 2552* (PRE).

SWAZILAND—2631 (Mbabane): Mbabane, *Rogers 11589* (BOL).

O.F.S.—2729 (Volksrust): Vrede, *O'Meara* in NBG *1127A/33* (BOL, NBG).

*Minima series:*

TRANSVAAL—2528 (Pretoria) Irene, *Leendertz 675* (PRE); 2531 (Komatipoort): Komatipoort, *Schlechter 11795* (BOL, PRE).

SWAZILAND—2631 (Mbabane): Bomon Ridge, *Karsten s.n.* sub NBG *58478* (NBG).

**3. *Ledebouria floribunda* (Bak.) Jess., comb. nov.**

*Scilla floribunda* Bak. in Saund., Ref. Bot. **3**: t.188 (1870). Type: "Cape of Good Hope", *Cooper s.n.* (K, holo.; PRE, photo.).

*Scilla pendula* Bak. in Saund., Ref. Bot. 3, app.: 14 (1870). Type: "Cape of Good Hope", Burchell s.n. (K, holo.; BOL, drawing!).

*Scilla princeps* Bak. in Saund., Ref. Bot. 3: t.189 (1870). Type: "Cape of Good Hope", Cooper s.n. (K, holo.; PRE, photo.).

?*Scilla spathulata* Bak. in Saund., Ref. Bot. 3: t.187 (1870). Type: Saund., Ref. Bot. 3: t.187, "Cape of Good Hope, Cooper s.n.", (1870).

*Scilla zebrina* Bak. in Saund., Ref. Bot. 3: t.185 (1870). Type: Saund., Ref. Bot. 3: t.185, "Cape of Good Hope, Cooper s.n.", (1870).

*Scilla polyantha* Bak. in Gdnrs' Chron. 9: 104 (1878). Type: Natal, York, in Hort. Bull s.n. (K, holo.; PRE, photo.).

*Scilla tricolor* Bak. in Gdnrs' Chron. 14: 230 (1880). Type: ?Cape, Port Elizabeth, Elwes (painting in K; PRE, photo of painting!; BOL, copy of painting!).

*Scilla subsecunda* Bak. in Gdnrs' Chron. 16: 38 (1881). Type: "Eastern districts of Cape Colony", Bowker (K, holo.; PRE, photo.; BOL, drawing!).

*Scilla microscypha* Bak. in Gdnrs' Chron. 16: 102 (1881). Type: "Eastern provinces of Cape Colony", Bowker (K, holo.; PRE, photo.).

*Scilla livida* Bak. in Gdnrs' Chron. 20: 166 (1883). Type: "Cape of Good Hope, imported by Messrs. F. Horsman & Co." (K, holo.; PRE, photo.; BOL, drawing!).

*Scilla megaphylla* Bak. in Fl. Cap. 6: 490 (1896). Type: Transvaal, near Barberton, Galpin 1184 (GRA!; NH!; SAM!, PRE, photo.).

*Scilla moschata* Schonl. in Rec. Albany Mus. 3: 60 (1914). Type: Cape, Stutterheim, Rogers 12786 (GRA, holo.; PRE, photo.).

*Scilla grandifolia* Schonl. in Rec. Albany Mus. 3: 61 (1914). Type: Transvaal, Tzaneen, Devil's Kloof, Rogers s.n., Dec. 1913 (GRA, holo.; PRE, photo.).

*Scilla lauta* N. E. Br. in Kew Bull. 1921: 299 (1921). Type: Transvaal, Pietersburg Div., the Downs, Rogers 23990 (K, holo.; PRE, photo.; BOL, drawing!).

*Bulbs* generally 70—150 mm long, usually more than a quarter of the length of the leaves. *Leaves* often 4 or 5, [140–] 200—350 [–450] mm long, 20—150 mm wide, more or less erect, fairly soft, linear-oblong to lanceolate, but not usually long-tapering. The outermost leaf not much smaller than the inner ones. *Inflorescence* more or less erect, often with 100 or more flowers. *Perianth segments* varying in colour—greyish, greenish or with pink, but not uniformly pink.

Occurs mainly in the northern and eastern Transvaal, Swaziland, Natal and the eastern Cape as far west as Grahamstown. Often recorded in seasonally damp places, but also occurs in drier localities such as slopes.

*S. livida* is placed in synonymy but shows leaf characters reminiscent of *L. concolor* and bulb characters of *L. revoluta*. However it does seem to be

best placed here. *S. subsecunda* is also placed here with some hesitation. It shows some affinities with both *L. revoluta* and *L. undulata*.

*L. floribunda* is nearest to the large forms of *L. cooperi*, but differs in having a relatively large number of flowers, which are not uniformly pink, and in the relatively large bulb, with darker outer scales. It is also not always possible to distinguish *L. floribunda* from large forms of *L. revoluta* and *L. concolor*, but the large inflorescence and often relatively narrow basal region of the lamina of the leaves provide useful characters. (See Flower. Pl. S. Afr. **23**: t.898; 1943.)

A number of specimens from Zululand (e.g. *Ward* 2822 (NH) from Hluhluwe Game Reserve and *Venter* 602 (NH) from Ngoya Mountain) appear to be best regarded as small-bulbed forms of *L. floribunda*.

*Selected specimens:*

TRANSVAAL—2531 (Komatipoort): near Barberton, *Van der Merwe* 2048 (PRE).

NATAL—2829 (Harrismith): Ladysmith, *Van der Merwe* 2603 (PRE); 2831 (Eshowe): "Intunzini", *Gerstner* s.n. sub NH 22103 (NH).

CAPE—3227 (Stutterheim): near Komgha, *Flanagan* 1112 (BOL, GRA, SAM).

**4. *Ledebouria socialis* (Bak.) Jess., comb. nov.**

*Scilla socialis* Bak. in Saund., Ref. Bot. **3**: t.180 (1870). *Type*: Natal, *Cooper* 3635 (K, holo.; PRE, photo.!).

*Scilla paucifolia* Bak. in Saund., Ref. Bot. **3**: t.181 (1870). *Type*: Saund., Ref. Bot. **3**: t.181, "Cape, *Cooper* s.n.", (1870).

*Scilla violacea* Hutch. in Kew Bull. **1932**: 511 (1932). *Type*: Cape, "Uitenhage Division", Klein River near Hankey, *Hutchinson & Long* s.n. (K, holo., PRE, photo.!, BOL!; PRE!).

*Bulbs* about 15—20 mm long, developed above the ground and usually producing colonies vegetatively. *Leaves* 2—3 [—5], 50—100 mm long, 10—15 mm broad, spreading to erect-spreading, lanceolate to oblong-lanceolate, sometimes with a petiole-like base to the lamina, somewhat fleshy, often deep pink or violet below and with a silvery sheen on the upper surface. *Inflorescence* more or less erect, often with fewer than 25 flowers.

Frequent in the eastern Cape between Uitenhage and East London, often on rather dry slopes, and possibly extending as far as Swaziland, but records are inadequate.

The epigeal bulb and somewhat spreading leaves distinguish this species from the smaller members of the *L. cooperi* complex. It also has affinities with *L. concolor*, which is a species of larger specimens often with undulate leaves and usually uniformly green leaves. (See Flower. Pl. S. Afr. **21**: t.825; 1941.)

The typification of this species presents a problem. Baker cited "Cape of

Good Hope, discovered by Mr. Cooper", but the locality given on the specimen, labelled "*Drimia socialis*, from the type plant", in Kew Herbarium, is Natal. Whether this specimen was incorrectly labelled or whether it is a valid record from Natal, where it is otherwise unrecorded, cannot be determined at the present time. This specimen does conform with both Saunder's figure and with the present author's concept of *L. socialis*.

The specimen labelled as the type of *S. paucifolia* (K, PRE, photo.!) does not match the Saunder's figure in bulb, leaf or inflorescence characters and is therefore not recognised as the type here.

*Selected specimens:*

CAPE—3326 (Grahamstown): Frasers Camp, *Barker* 6986 (NBG); Hopewell, *Acocks* 12072 (PRE); 3327 (Pieddie): Wooldridge, *Bayliss* BS/3224 (RUH).

5. ***Ledebouria concolor*** (Bak.) Jess., comb. nov.

*Drimia cooperi* Bak. in Saund., Ref. Bot. **1**: t.18 (1868), non *Scilla cooperi* Hook. f., 1866. *Type*: Cape of Good Hope, *Cooper* s.n. (K, holo.; PRE, photo.!).

*Scilla concolor* Bak. in Saund., Ref. Bot. **3**, app.: 13 (1870). *Type*: as for *Drimia cooperi*.

*Bulbs* 30—50 mm long, epigeal and usually reproducing vegetatively to form colonies. *Leaves* 2—6, erect to erect-spreading, 50—150 mm long, 15—50 mm broad, broadly lanceolate to oblong-lanceolate, usually with undulate margins, never attenuate. *Inflorescence* more or less erect, not usually with more than about 100 flowers. *Flowers* usually (?always) green.

This species occurs only in the Port Elizabeth—Uitenhage areas of the eastern Cape. Its habit is rather like a large form of *L. socialis*, but with undulate leaves, lacking the silvery markings and probably also the pink on the lower leaf surfaces usually present in *L. socialis*. The leaves are probably never spotted with either pink or with different shades of green.

*Drimia nitida* Eckl. in S. Afr. Quart. J., no. **1**: 364 (1830) appears to be synonymous with *L. concolor*, but as no type material has been seen it has been preferred to the use of the latter name. *D. nitida* was reported to have been collected at Addo, eastern Cape.

*Selected specimens:*

CAPE—3325 (Port Elizabeth): Addo Bush, *Long* 240, 241 (GRA); Glenconnor, *Long* 1320 (PRE).

6. ***Ledebouria apertiflora*** (Bak.) Jess., comb. nov.

*Drimia apertiflora* Bak. in Saund., Ref. Bot. **1**: t.19 (1868). *Type*: Saund., Ref. Bot. **1**: t.19, "Cape, *Cooper* s.n.", (1868).

*Scilla lorata* Bak. in Saund., Ref. Bot. 3, app.: 14 (1870), nom. superfl., type as for *Drimia apertiflora*.

*Scilla apertiflora* (Bak.) C. A. Sm. in Kew Bull. 1930: 250 (1930).

*Scilla linearifolia* Bak. in Saund., Ref. Bot. 3: t.184 (1870). Type: Saund., Ref. Bot. 3: t.184, "Cape, Cooper s.n.", (1870).

*Bulbs* 40—60 mm long, often pink towards the top. *Leaves* 4—7, erect, usually 200—350 mm long, and less than 25 mm broad, sublinear, tapering almost from the base. *Inflorescence* erect or flexuose, often with 50—150 flowers.

Although both types cited above originated in the Cape, the species as defined here appears to be largely restricted to Natal and the eastern Transvaal in South African herbaria. *Strey* 4487 (NH) from "Bizaia, Bizana Distr.", may belong here but lacks a bulb. This throws some suspicion on the validity of this concept of *L. apertiflora*, but in taking this view the present author is not only expressing his own opinion, but also upholding that of Van der Merwe. *Wood* 1208 (NH), from Inanda, Natal, was selected by Van der Merwe as a good match of the type of *S. linearifolia* (MS in PRE). This view appears to be well-founded. Although it is felt that it is justified to place *S. linearifolia* and *S. lorata* (both sensu Baker, 1896) in a single species, the breadth of leaf mentioned in Baker's type description of *Drimia apertiflora* is exceptionally great for the species as construed here. In other ways, too, this may be shown to be an unsatisfactory grouping of the material. *L. apertiflora* shows similarities with *L. cooperi* (cooperi series) from which it may be separated by having a larger bulb and more attenuate and perhaps firmer leaves. In the Transvaal it may also be confused with long-leaved forms of *L. undulata*. The bulb is never produced into a neck, and the leaves are longer. The low-veld forms and some Natal plants of *L. revoluta*, as defined in this review, also approach this species, but have broader leaves.

*Selected specimens:*

TRANSSVAAL—2531 (Komatipoort): Malelane, Lang s.n. sub Tvl Mus. 30410 (PRE).

NATAL—2732 (Ubombo): Josini Dam, Moll & Strey 3649 (NH, PRE); 2930 (Pietermaritzburg): 10 miles north of Greytown, Mogg s.n. (PRE).

7. *Ledebouria revoluta* (L.f.) Jess., comb. nov.

*Hyacinthus revolutus* L.f., Suppl.: 204 (1781). Type: "Cap. bonae spei", Thunberg s.n. (UPS, holo.; BOL & PRE on Herb. Thunb. Microfiche no. 8508!).

*Phalangium revolutum* (L.f.) Pers., Syn. Pl. 1: 367 (1805).

*Drimia* (?) *revoluta* (L.f.) Kunth, Enum. Pl. 4: 341 (1843).

*Xeodolon revolutum* (L.f.) Salisb., Gen. Pl.: 18 (1866).

*Scilla revoluta* (L.f.) Bak. in Saund., Ref. Bot. 3, app.: 6 (1870).

*Lachenalia lanceaefolia* Jacq., Icones 2: t.402 (1794). Type: Jacq., Icones 2: t.402 (1794).

*Drimia lanceaefolia* (Jacq.) Ker-Gawl. in Curtis's bot. Mag. 33: t.1380 (1811).

*Sugillaria lanceaefolia* (Jacq.) Salisb., Gen. Pl.: 18 (1866).

*Scilla lanceaefolia* (Jacq.) Bak. in Saund., Ref. Bot. 3: t.182 (1870).

*Lachenalia maculata* Tratt., Archiv. der Gewächskunde 2: t.168 (1814). Type: Tratt, Archiv. der Gewächskunde 2: t.168 (1814).

*Scilla maculata* Shrank, Pl. Rar. Hort. Acad. 2: fol. 100, t.100 (1820). Type: Shrank, Pl. Rar. Hort. Acad. 2: fol. 100, t.100, "Promontorium Bonae Spei", (1820).

*Drimia acuminata* Lodd., Bot. Cab.: t.1041 (1825). Type: Lodd., Bot. Cab.: t.1041, "Cape of Good Hope", (1825).

*Scilla asperifolia* Van der Merwe in Flower. Pl. S. Afr. 24: t.944 (1944). Type: Natal, Ladysmith, Van der Merwe 2604 (PRE, holo.!; NU!).

*Scilla carnosula* Van der Merwe in Flower. Pl. S. Afr. 24: t.958 (1944). Type: Natal, Greytown, Van der Merwe 2592 (PRE, holo.!).

*Scilla albomarginata* Van der Merwe in Flower. Pl. S. Afr. 24: t.947 (1944). Type: Natal, near Umzinto, Van der Merwe 2669 (PRE, holo.!).

*Bulbs* 25—75 mm long; the outer scales often dark and glossy or with pink, often in the form of speckling, especially in the upper parts. *Leaves* 4—8, appressed to the ground, spreading or suberect, often not developing very far before flowering, but rarely over 150 mm long, up to 30 mm broad, ovate to lanceolate, usually attenuate; linear to linear-lanceolate in the early stages of leaf growth. *Inflorescence* suberect or suberect in the distal half and spreading in the lower half, usually with fewer than 100 flowers.

Occurs generally from Greyton (3419B; Caledon) through the belt between the karoo and the sea into Natal and the Transvaal, but rare west of Port Elizabeth. Also recorded from S.W.A. and the O.F.S.

In the south-west of its range it is a relatively small plant with a more or less erect inflorescence (Flower. Pl. S. Afr. 23: t.913; 1943). *Muir* 1877 (BOL) from Riversdale is a very close match with the type of *Hyacinthus revolutus*. In much of the eastern Cape (e.g. *Dyer* 1142; GRA) the fully-developed outer leaves are firmly appressed to the ground, and the inflorescence is suberect. In the Transvaal highveld the leaves are erect-spreading, the bulb relatively large and the inflorescence flexuose. As the orientation of the leaves is strongly affected by the density of the surrounding vegetation, this does not appear to offer a satisfactory character for subdividing the *L. revoluta* complex.

Many specimens, especially from the lowveld, for example *Ward* 3288 (NH)



from the Hluhluwe Game Reserve in Natal, have well-developed leaves at anthesis. It has also not been found possible to separate this form taxonomically. Similarly, the gradation in the size and form of other organs makes it difficult to find any other suitable character for subdividing this complex.

The only other species with leaves appressed to the ground is *L. ovatifolia* which has a different type of bulb and usually broader, less attenuate leaves. Specimens linking this complex with the *L. cooperi* complex occur over much of its range (e.g. *Van der Merwe* 1554 (PRE) from near Leslie in the Bethal district). Other specimens exist which are intermediate between *L. revoluta* and *L. floribunda* (e.g. *Young* A365 (PRE) from Schoeman's Kloof in the Belfast district).

The leaves of the type of *S. albomarginata* are more like those of *L. ovatifolia*, but the bulb places it rather in *L. revoluta*.

*Selected specimens:*

S.W.A.—1920 (Tsumkwe): Nama Pan, *Story* 5181 (PRE).

TRANSVAAL—2630 (Carolina): Carolina, Witkloof, *Van der Merwe* Sc3 (PRE).

CAPE—3326 (Grahamstown): Penrock Farm, 8 miles from Grahamstown, *Dyer* 1142 (GRA); 3421 (Riversdale): Melkhoutfontein, *Muir* 1877 (BOL).

8. *Ledebouria inquinata* (C. A. Sm.) Jess., comb. nov.

*Scilla inquinata* C. A. Sm. in Kew Bull. 1930: 248 (1930). *Type*: Transvaal, near Pretoria along the Aapies River, *Burke* s.n. (K, holo.; PRE, photo.!).

*Bulbs* 25—65 mm long, the outer scales often dark and glossy or with a pink tinge especially in the upper parts. *Leaves* erect, ovate-lanceolate narrowing towards the base, up to 150 mm long, 35 mm broad, very glaucous and usually not conspicuously spotted, often poorly developed at flowering. *Inflorescence* flexuose to suberect, with 50—150 flowers.

Wide-spread in the Transvaal but apparently rare in the lowveld and not collected in the other provinces.

The bulb is similar to that of *L. revoluta* and *L. marginata* but the pink colour tends to be present as a uniform wash rather than as spots and the bulbs divide to form two cohering daughter bulbs more frequently than in the other two species. The erect very glaucous leaves, which usually lack spots are also characteristic. At flowering the attenuate apices of the leaves are often all that show of the leaf, but the narrowing of the leaf towards the base contrasts with the broader base of the other two species. Nevertheless it is not always possible to distinguish *L. inquinata* and *L. revoluta* and it is considered possible that with further data it may be decided not to uphold *L. inquinata*.

*Selected specimens:*

TRANSVAAL—2427 (Thabazimbi): Road from Rooiberg to Warmbaths, *Van der Merwe* 1965 (PRE); 2528 (Pretoria): Pienaars Poort, *Leeman* s.n. sub PRE 30529 (PRE); Premier Mine, *Rogers* 9825A (Z).

9. *Ledebouria undulata* (Jacq.) Jess., comb. nov.

*Drimia undulata* Jacq., *Icones* 2: t.376 (1794). *Type*: Jacq., *Icones* 2: t.376 (1794).

*Scilla undulata* (Jacq.) Bak. in Saund., *Ref. Bot.* 3, app.: 11 (1870); nom. illegit., non *S. undulata* Desf., 1798.

*Scilla undulatifolia* Von Poelln. in *Ber. dt. bot. Ges.* 41: 209 (1944). *Type*: as for *Drimia undulata* Jacq.

*Drimia ensifolia* Eckl. in *S. Afr. Quart. J.* 1: 364 (1830). *Type*: Cape, Zwartkops, "Uitenhage", *Zeyher* 10 (K, lecto.; PRE, photo.!).

*Scilla ensifolia* (Eckl.) Britten in *J. Bot., Lond.* 46: 201 (1908).

*Scilla prasina* Bak. in Saund., *Ref. Bot.* 3, app.: 10 (1870). *Type*: "Kaffirland", *Gill* s.n. (K, holo.; PRE, photo.!).

?*Scilla laxiflora* Bak. in *Gdnrs' Chron.* 9: 668 (1891). *Type*: ?"Hort. N. E. Brown" (K, ?holo.; BOL, drawing!).

*Scilla ecklonii* Bak. in *Bot. Jb.* 15, Beibl. 35: 7 (1892). *Type*: Cape, *Ecklon & Zeyher* *Asphod.* n. 12 (B, holo.!).

*Scilla nelsonii* Bak. in *Fl. Cap.* 6: 488 (1896). *Type*: South Africa, without locality, *Burke* s.n. (K; PRE, photo.!).; Vaal River, *Nelson* 167 (K; PRE, photo.!).; PRE!—the specimen in PRE lacks a bulb but may be nearer *L. cooperi*.

*Scilla rautanenii* Schinz in *Bull. Herb. Boissier* 5: 857 (1897). *Type*: Kaokoveld, *Rautanen* 172 (Z, holo.!).

*Drimiopsis engleri* Krause in *Bot. Jb.* 51: 445 (1914). *Type*: S.W.A., "Narib: am Fuss der Kalaharihügel, *Engler* 6534 (B, holo.!).

*Bulbs* 20—50 mm long, often either with numerous dry outer scales and abruptly truncate at the apex or produced into a neck which may be as long as or longer than the bulb; the roots sometimes in the form of narrow, elongate fusiform tubers (see *Flower. Pl. S. Afr.* 21: t.826; 1941). *Leaves* 2—6, narrowly linear-lanceolate to lanceolate, more or less erect to spreading, rather firm, sometimes distichous, often folding longitudinally, usually 50—150 mm long, rarely over 20 mm broad. *Inflorescence* erect.

A species-complex of the dry parts of South Africa and South West Africa, occurring from the southern Cape to the Transvaal.

Small forms can be confused with the *L. cooperi* complex (e.g. *Wylie* s.n. sub *Tvl. Mus.* 34294 (PRE) from Greytown, Natal), but the several dry outer bulb scales, especially when these form a neck, the relatively firm leaves and bicoloured or greenish flowers assist in distinguishing them.

The type of *Scilla prasina* is considered by the present author to belong to this species despite having exceptionally broad leaves.

There isn't absolute certainty that the specimen cited as the type of *S. laxiflora* is in fact the type. But it agrees with the description and both specimen and description belong within this concept of *L. undulata*.

When difficulty is experienced in separating *L. undulata* from *L. revoluta* (e.g. *Acocks* 16315 (PRE) from Dwaal Station in the Hanover district), a pedicel length below 5 mm can be regarded as an indication of *L. undulata*. Other specimens, for example *Strey* 3475 (PRE) from Mopane in the Soutpansberg district, show affinities with *L. apertiflora*.

*Selected specimens:*

S.W.A.—2718 (Grunau): Naruda Süd, *Pearson* s.n. sub P. Sladen Expedition of 1912–13 no. 7990 (BOL).

O.F.S.—2925 (Jagersfontein): Fauresmith, Groenvlei, *Henrici* 3802 (PRE).

CAPE—3318 (Cape Town): Hopefield, *Bolus* 12891 (BOL); 3325 (Somerset East): Boschberg, *MacOwan* 1842 (GRA).

**10. *Ledebouria graminifolia* (Bak.) Jess., comb. nov.**

*Scilla graminifolia* Bak. in Bull. Herb. Boissier, ser. 2, 4: 1001 (1904). *Type*: Transvaal, Modderfontein, *Conrath* 703 (K, holo.; PRE, photo.!, BOL, drawing!; GRAZ; Z!).

*Scilla stenophylla* Van der Merwe in Flower. Pl. S. Afr. 25: t.959 (1944). *Type*: Natal, Paulpietersburg, *Van der Merwe* 2655 (PRE, holo.!).

*Bulbs* 30—50 mm long. *Leaves* 10—20, linear, 40—80 mm long, 1—4 mm broad, usually spirally twisted. *Inflorescence* suberect, rather dense, often with about 30—70 flowers.

Occurs mainly in the Transvaal, where it is wide-spread, and recorded from northern Natal.

In many respects *L. graminifolia* is intermediate between the minima series of *L. cooperi* and *L. undulata*. The bulbs are intermediate in size, but the length, shape and spiral twisting of the leaves are diagnostic. The twisting is, however, not always apparent, particularly at flowering, when the leaves may be poorly developed. The bicoloured flowers and large number of leaves further serve to distinguish it from *L. cooperi*. Like *L. undulata* the bulb may be extended to form a sheath at the base of the lamina of the leaves. It may not be possible to distinguish this species from *L. marginata* before the leaves are well-formed, but the broader leaf with several raised veins characterises *L. marginata* later in growth.

In some specimens with leaves of the form characteristic of *L. graminifolia* the bulb scales may produce copious threads when torn as in *L. ovatifolia* and *L. luteola*. But such specimens are probably best placed in *L. luteola* (e.g.

Smith 8602B (PRE) from Vaalbank in the Bloemfontein district). It does seem possible that *L. graminifolia* and *L. luteola* hybridise. Both occur at Modderfontein and the sheet of *Conrath* 703 in Zurich shows a typical plant of *L. graminifolia* (left-hand specimen on sheet) and of a specimen intermediate between these species but probably closer to *L. luteola*.

*Selected specimens:*

TRANSSVAAL—2628 (Johannesburg): Modderfontein, *Van der Merwe* 1986 (PRE); 2730 (Vryheid): between Wittenberg and Bergen, *Acocks* 11735 (BOL, NH, PRE).

11. *Ledebouria marginata* (Bak.) Jess., comb. nov.

*Scilla marginata* Bak. in Bull. Herb. Boissier, ser. 2, 4: 1002 (1904). *Type:* Transvaal, Modderfontein, *Conrath* 703b (GRAZ, lecto.; PRE, photo.!, Z!).

*Scilla neglecta* Van der Merwe in Flower. Pl. S. Afr. 22: t.865 (1942). *Type:* Transvaal, Pretoria, Colbyn, *Van der Merwe* 2441 (PRE, holo.!).

*Bulbs* 40–80 mm long; the outer scales often dark and glossy with pink markings. *Leaves* 4–10 [–16], erect, firm, with prominent veins, up to 160 mm or rarely more long, 10–30 mm broad. *Inflorescence* usually flexuose, with 50–150 flowers.

Occurs from the eastern Cape (Aliwal North and Queenstown) through the O.F.S., Natal and Lesotho and over most of the Transvaal except, perhaps, the lowveld. The bulb is very similar to that of forms of *L. revoluta* from the Transvaal, but the leaves are more attenuate and much firmer—retaining their shape so that, after growth has commenced in spring, the previous season's dead leaves often persist. They are similar in texture to the leaves of *Scilla nervosa*, but the rigidity is given by collenchyma not sclerenchyma as in *S. nervosus*.

*Selected specimens:*

TRANSSVAAL—2428 (Nylstroom): 5 miles east of Warmbaths, *Collett s.n.* (PRE).

O.F.S.—2824 (Kimberley): 14 miles north-east of Kimberley, *Leistner* 2875 (PRE).

LESOTHO—2927 (Maseru): Roma, *Schmitz* 30 (PRE).

CAPE—3026 (Aliwal North): Aliwal North, *Gerstner* 67 (PRE).

12. *Ledebouria luteola* Jess., sp. nov., *L. marginatae* (Bak.) Jess. affinis, sed minor, bulbo luteolo et squamis bulbi ubi laceratis fila plurima exhibentibus.

Bulbi squamis exterioribus brunneis, sed squamis interioribus luteolis, 35–40 mm longi; squamae ubi laceratae fila plurima exhibentes. Folia 6–10, erecta, angusto-lanceolata, 45–90 mm longa, viridia, fasciis indistinctis transversis. Inflorescentiae 1 vel 2, suberectae, 80–90 mm longae, compactae. Pedicelli c. 30–50, patentes, reflectescentes. Perianthii segmenta suberecta, c. 4 mm longa, longitudine fasciata.

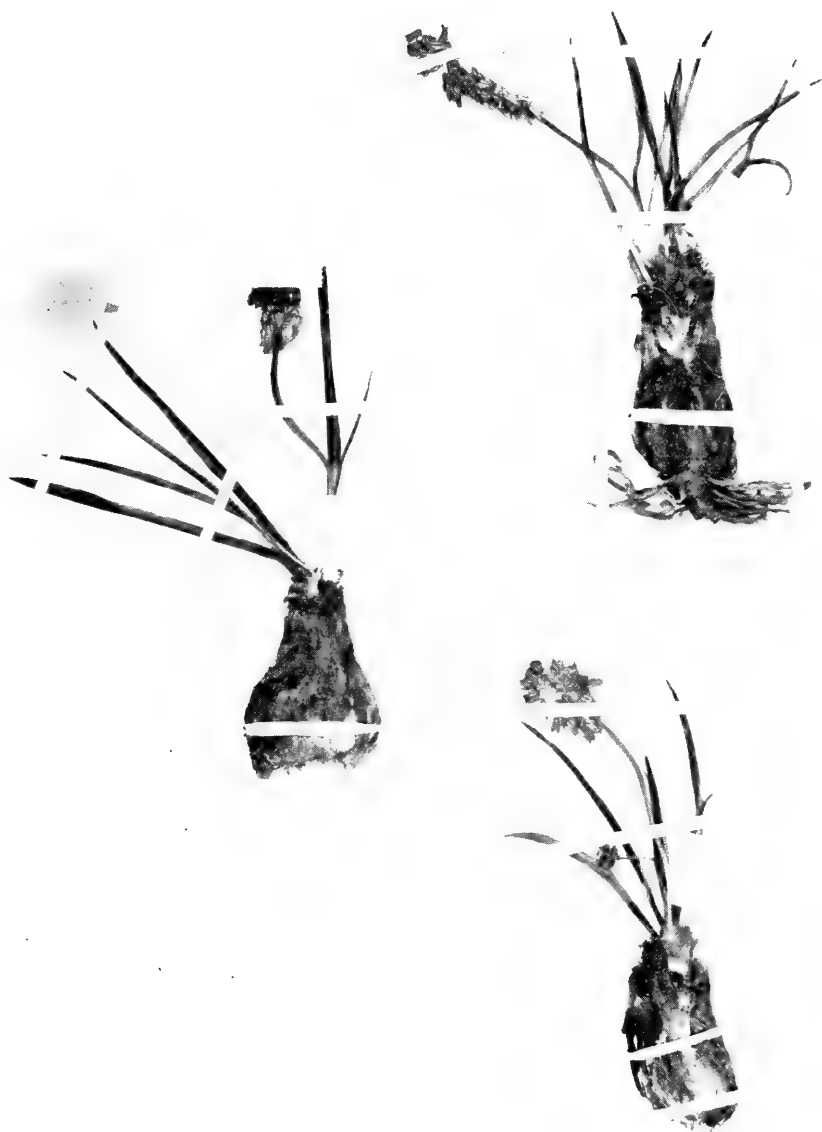


FIG. 4.—Holotype of *Ledebouria luteola*, sp. nov. (Codd 5625; PRE). x 1/3.

*Type:* Transvaal; Pretoria (2528),  $6\frac{1}{2}$  miles south of Hammanskraal, *Codd* 5625 (PRE, holo.).

*Bulbs* 35—50 mm long; the scales producing copious threads when torn; the inner scales yellow. *Leaves* 4—10, erect or arcuate, up to 80 [—130] mm long, lanceolate to linear-lanceolate, spotted or transversely marked, rather firm. *Inflorescence* more or less erect, with 30—60 flowers.

Occurs widely in the Transvaal, northern O.F.S. and north-western Natal, particularly in dampish areas.

Small forms (e.g. *Van der Merwe* 1289 (PRE) from Pilgrim's Rest) are not readily distinguishable from the form of *L. cooperi* described by Van der Merwe under the epithet *rupestris*.

Narrow-leaved forms may be difficult to separate from *L. graminifolia* but the bulb is apparently diagnostic. There are also specimens linking it with *L. marginata* (e.g. *Conrath* 696 (Z) from Modderfontein, near Johannesburg).

*Selected specimens:*

TRANSVAAL—2330 (Tzaneen): Tzaneen, *Van der Merwe* 1177 (PRE);  
2527 (Rustenburg): 22 miles west of Rustenburg, *Van der Merwe* 1127 (PRE);  
2530 (Lydenburg): Belfast, *Van der Merwe* 1832 (PRE).

13. *Ledebouria ovatifolia* (Bak.) Jess., comb. nov.

*Scilla ovatifolia* Bak. in Saund., Ref. Bot. 3: t.183 (1870). *Type:* Natal, *Cooper* s.n. (K, holo.; PRE, photo.!).

*Scilla lanceaefolia* sensu Wood, Natal Pl. 3 (4): t.202 (1900), non *Lachenalia lanceaefolia* Jacq.

*Scilla climacocarpha* C. A. Sm. in Kew. Bull. 1930: 249 (1930). *Type:* O.F.S., near Bethlehem in a damp shady ravine, *Phillips* 3068 (PRE!).

*Scilla guttata* C. A. Sm. in Kew. Bull. 1930: 243 (1930). *Type:* Natal, "Durban Div.", *Cooper* s.n. (K, holo.).

*Scilla cicatricosa* C. A. Sm. in Kew. Bull. 1930: 246 (1930). *Type:* Wood, Natal Pl. 3 (4): t.202 (1900).

*Scilla elevans* Van der Merwe in Flower. Pl. S. Afr. 24: t.948 (1944). *Type:* Natal, Vryheid, *Van der Merwe* 2677 (PRE!).

*Scilla collina* Hutch., Bot. in S. Afr.: 344 (1946). *Type:* Transvaal, Soutpansberg, Klein Australe, *Smuts & Gillett* 4186 (K, holo.; PRE, photo.!).

*Bulbs* [30—] 40 [—150] mm long; membranous outer scales lacking or very insignificant; the scales rather truncate and vertically imbricate; the outermost very short and only the innermost reaching the top of the bulb; all producing copious threads when torn. *Leaves* 2—5, usually firmly appressed to the ground, up to 250 mm long, ovate, with a broad base. *Inflorescence* usually flexuose, with about 50—150 densely packed flowers.

Occurs, perhaps as far west as Grahamstown in the eastern Cape, through Natal, Lesotho and into most of the Transvaal. There are a few records from the O.F.S.

The bulb characters, described above, do not occur in any other species of *Ledebouria* in South Africa. Only in *L. luteola* are threads apparently produced in such large quantities. These threads have been described as removable spiral thickenings of the xylem conducting elements (Badenhuizen, 1954, in *Protoplasma* **43** (4): 429–440).

In his description of *S. elevans*, Van der Merwe stated that his new species only differed from *S. ovatifolia* in having erect leaves, "which do also sometimes occur in that species as well". This difference in leaf position is almost certainly sometimes produced by genetic factors. But it does not, in the opinion of the present author, constitute a satisfactory character on which to subdivide the complex, particularly as in many cases the same effect may be produced entirely by environmental factors.

In shady places, especially plantations, the leaves may be suberect and linear-lanceolate, making them indistinguishable from those of the larger forms of *L. cooperi*.

See Flower. Pl. S. Afr. **21**: t.830 (1941) for an illustration of the commonest form.

*Selected specimens:*

TRANSVAAL—2528 (Pretoria): Fountains Valley, Van der Merwe 2001 (PRE).

NATAL—2931 (Stanger): Claremont, Schlechter 2940 (unusually small form) (BOL, GRA).

CAPE—3029 (Kokstad): Kokstad, Tyson 1123 (BOL, SAM).

**14. *Ledebouria hypoxidioides* (Schonl.) Jess., comb. nov.**

*Scilla hypoxidioides* Schonl. in Rec. Albany Mus. **1**: 48 (1903). *Type*: Cape, Grahamstown, behind Fort England, Daly & Sole 435 (GRA, holo.!; BOL!; SAM!; Z!).

*Bulbs* 25–40 mm long, sometimes produced into a short neck, sometimes pink towards the top. *Leaves* 2–4, 60–150 mm long, 15–35 mm broad, suberect, ovate-oblong to oblong-lanceolate, moderately firm, densely silky white pubescent on both surfaces. *Inflorescence* more or less erect, often with about 75–150 flowers.

This species has only been recorded in the immediate vicinity of Grahams-town. The hairy leaves render it unmistakable, as there is no other known pubescent species of *Ledebouria*. Schonland (1903) states: "It grows amongst grass and also in rocky situations at an altitude of about 1,700 to 2,300 feet. Its silky haired leaves resemble those of some species of *Hypoxis* . . ."

*Selected specimens:*

CAPE—3326 (Grahamstown): Hills above Grahamstown, *Van der Merwe 2138* (PRE).

15. *Ledebouria viscosa* Jess., sp. nov. affinitate non manifesta. A speciebus omnibus *Ledebouriae* foliis viscidis differt.

Bulbi axibus basaliter elongatis, 50—55 mm longi, 12—15 mm lati. Folia ?1—3, erecta, oblanceolata-spathulata, 100—140 mm longa, 20—30 mm lata, viscida. Inflorescentiae erectae, solitariae, 150—170 mm longae. Pedicelli 20—30, patentes, c. 8 mm longi. Perianthii segmenta suberecta, c. 5 mm longa.

*Type:* Transvaal; Thabazimbi (2427), Kransberg, *Meeuse 10493* (PRE, holo.).

*Bulbs* 50—100 mm long, 12—20 mm broad, with the axis greatly extended below the succulent parts of the leaf bases (see plate 2). *Leaves* 1—3, erect, oblanceolate-spathulate, 90—230 mm long, 17—30 mm broad, viscid. *Inflorescence* erect with about 20—30 rather widely spaced flowers.

Only recorded from the type area. It differs from all other known species of *Ledebouria* in having viscid leaves and in the shape of both the leaves and the bulbs. Its affinities are obscure. Although other collectors have recorded the viscid nature of the leaves and although the leaves of both herbarium specimens and specimens examined in the field by the author have large numbers of sand particles adhering, it was found that the leaves are not actually sticky to the touch. Whether the stickiness is a feature of the leaves only at certain times of the year or at certain stages of development has not been ascertained. It was also noticed that certain other plants, especially a species of grass, also had sand adhering to the leaves, introducing the possibility that it is a characteristic of the sand rather than of the *Ledebouria*. It grows on loose red sands.

*Dyer & Ehrens 4201* (PRE) is interesting as it is in fruit; fruit not often having been collected in *Ledebouria*.

*Selected specimens:*

TRANSVAAL—2427 (Thabazimbi): Farm Waterval on the western side of the Kransberg in sandy soil in the open, *Dyer & Ehrens 4201* (PRE).

*Nomina dubia*

*Drimia ludwigii* Miquel in Bull. Scien. Phys. Neerl. 1839: 39—40 (1839). No type cited and description inadequate.

*Skilla filiformis* Rafin., Autikon Botanikon: 56 (1840). No type cited and description inadequate.

*Drimia angustifolia* Kunth, Enum. Pl. 4: 340 (1843). *Type:* Drège 8618b. Not traced and description inadequate.

*Drimia dregeana* Kunth, Enum. Pl. 4: 340 (1843). *Type:* Cape, Drège 1616c. Not traced and description inadequate.





FIG. 5.—Holotype of *Ledebouria viscosa*, sp. nov. (Meeuse 10493; PRE).  $\times 1/3$ .

*Idothea* (?) *ludwigii* (Miquel) Kunth, Enum. Pl. **4**: 681 (1843).

*Drimia viridiflora* Eckl., Topogr. Verzeichn. der Pflanzensammlung van Chr. Fr. Ecklon (1827). *Type*: Zeyher s.n., Oct. 1825. This specimen has not been located and there is no description.

*Drimia viridiflora* Kunze in Linnaea **20**: 10 (1847). Described from a bulb sent from the Cape by Gueinzus; but with the following note: "Speciem esse Ecklonianum e solo nomine suspicor; nam specimina nondum vidi." This specimen has also not been located, nor is his plant identifiable from his description.

*Scilla exigua* Bak. in J. Linn. Soc. (Bot.) **13**: 247 (1873). *Type*: Natal, Camperdown, Assegai Kraal, *Sanderson* 670. Not located and description inadequate.

*Scilla ludwigii* (Miquel) Bak. in Saund. Ref. Bot. **3**, app.: 9 (1870).

*Scilla barberi* Bak. in J. Linn. Soc. (Bot.) **13**: 247 (1873). *Type*: Cape, "ad ripas fluminis Tsomo", *Barber* 805. Not located and description inadequate.

*Scilla viridiflora* (Kunze) Bak. in J. Linn. Soc. (Bot.) **13**: 255 (1873).

*Scilla ondongensis* Schinz in Vierteljahrsschr. Nat. Ges. Zurich **42**: 535 (1912). *Type*: Ovamboland, Ondonga, *Alma Kestila* 36a. Not located and description inadequate.

*Scilla kestilana* Schinz in Vierteljahrsschr. Nat. Ges. Zurich **42**: 535 (1912). *Type*: Ovamboland, Ondonga, *Alma Kestila* 36b. Not located and description inadequate.

*Scilla xanthobotrya* Von Poelln. in Portug. Acta Biol., ser B., **1**: 213 (1944). *Type*: Transvaal, "Waterfall River bei der Stadt Lydenburg", *Wilms* 1518. Not located and description inadequate.

#### *Nomina exclusa*

*Hyacinthus flexuosus* Thunb., Prodr. Fl. Cap.: 64 (1794). *Type*: South Africa, *Thunberg* s.n. Specimen in the Thunberg Herbarium in Uppsala is not a *Scilla* or *Ledebouria*; possibly a species of *Ornithogalum*.

*Scilla flexuosa* (Thunb.) Bak. in J. Linn. Soc. (Bot.) **13**: 245 (1873).

*Scilla pearsonii* Glover in Ann. Bolus Herb. **1**: 105 (1915). *Type*: Central Karasberg, Scharfenstein, P. S. Ex. 1912/13 7989 (BOL, holo.; PRE, photo.). = *Lachenalia pearsonii* (Glover) Barker in J. S. Afr. Bot. **35**: 321 (1969).

*Scilla baumiana* Engl. & Gilg. in Warb., Kunene-Samb.-Exped.: 195 (1903). *Type*: "An der Chitandamindung . . .", *Baum* 122 (Z!). = *Urginea* sp.

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An index to binomials will be prepared for inclusion after the second part of this series.

## TAXONOMIC NOTES ON ERICA

H. A. Baker

### ABSTRACT

A new species of *Erica*, *E. turrisbabilonica* H. A. Baker and a new variety, *E. aristata* Andr. var. *turrisbabilonica* H. A. Baker, are proposed. *Erica ionii* H. A. Baker is considered synonymous with *E. manifesta* Compton.

### SAMEVATTING

TAKSONOMIESE AANTEKENINGE OOR ERICA. 'n Nuwe *Erica* soort, *E. turrisbabilonica* H. A. Baker en 'n nuwe variëteit, *E. aristata* Andr. var. *turrisbabilonica* H. A. Baker word voorgestel. *E. ionii* H. A. Baker word as 'n sinoniem van *E. manifesta* Compton geag.

***Erica turrisbabilonica*** H. A. Baker, sp. nov., (Ericaceae-Ericoideae) *Callista*.

Frutex erectus, subvirgatus ad 30 cm altus. *Rami* juniores villosi, glabrescentes. *Folia* 4—nata, 4—7 mm longa, erectopatentia, initio imbricata demum internodia foliis longiora, liniaria, subulata, acutata, sulcata, sparsum hirta vel glabra, ciliata piliis albis, tenuibus, longiusculis. *Flores* laterales, solitarii; pedunculati circa 11 mm longi, villosi; bractae 2, 4—5 mm longae, medianae, foliaceae. *Sepala* 6—8 mm longa, aliquantum variabiles, plerumque foliacea sed interdum basibus ovatis et scarioso marginatis. *Tubus corollae* c. 1.6 cm longus, initio anguste tubulatus, circum antherae leviter inflatus, e basi varie inflatescens et, post maturitatem aspectu tubulo ampullaceus, siccus, breviter et copiosus hispidus, primo viridis, rubropurpureus; lobi c. 7 mm longi, 3 mm lati, stellatopatentes, ovati, acuti, basibus angustibus extus rubropurpurei, intus indumento albo. *Filamenta* gracilia, sigmoidea; antherae inclusae, minus quam 1 mm longae, laterales, oblongae, obtusae, muticae; poro fere dimidio pars lobi. *Ovarium* elongatum, glabrum; stylus manifestus; stigma capitatum.

Erect subvirgate shrub to about 30 cm in height. *Branches* villous-pubescent at first, glabrescent. *Leaves* 4—nate, 4—7 mm long, erect-spreading, imbricate at first, later the internodes much longer than the leaves, linear-subulate, acute, sulcate, glabrous or sparsely hairy, ciliate with longish, fine white hairs. *Flowers* solitary in the leaf axils; peduncles about 11 mm long, villous-pubescent; bracts 2, about 4—5 mm long, median, foliaceous. *Sepals* about 8 mm long, somewhat variable in shape, mostly foliaceous but some with a small ovate,

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Accepted for publication 15th April, 1970.

scarious-edged base. *Corolla-tube* about 1.6 cm long, at first narrow-tubular and slightly inflated at the throat, gradually becoming inflated below in varying degrees and appearing tubular-ampullaceous after maturity, dry, minutely but copiosely hispid, at first green, becoming purplish-red; lobes 7 mm long  $\times$  3 mm wide, stellately spreading at maturity, ovate acute with a narrow but not imbricating base, coloured outside as corolla-tube, inside with a white indumentum. *Filaments* slender, sigmoid near the apex; anthers included, less than 1 mm long, lateral, oblong, obtuse, mucous; pore about half the length of the cell. *Ovary* elongate, glabrous; style manifest; stigma capitate.

CAPE—3419 (Caledon): Marshes and wet rocky places on the Southern slopes of Babylon's Tower mountain c.610—1066 m (—AD), December 1969, W. P. U. Jackson s.n. (BOL 30663 holotype; isotypes NBG, PRE, STE).

*Erica turrisbabylonica* appears at first sight to be a typical member of the section *Callista* resembling *E. fastigiata* L. var. *coventryana* Bolus or *E. law-*



FIG. 1. *Erica turrisbabylonica* H. A. Baker.  
View from above and side view of flowers, approx. life-size.

*sonia* Andr. but, on closer inspection, is found to differ therefrom in several important respects and also from the definition of the section *Callista* in *Flora Capensis*. This postulates terminal flowers on very short peduncles with approximate bracts (presumably 3 as in all the specimens described). The species here described must, therefore, be considered to be an exception in this section for it will not fit into any other.

Geographically the species appears to be confined to the range of mountains known as Babylon's Tower where it grows in abundant colonies in the numerous kloofs on the southern slopes in marshy places. Here the plants are slender

but it also grows in wet, rocky places where the plants are much more woody and spreading. This range is separated from the Klein River Mts. to the South, on which grows *E. fastigiata* var. *coventryana*, by a valley some 4 miles wide.

The species was first collected in January 1969 when mostly past its prime by Dr. L. Vogelpoel who brought it to the notice of the author and also in December 1969 by Dr. W. P. U. Jackson, whose collection forms the type material.

***Erica aristata* Andrews var. *turrisbabylonica* H. A. Baker var. nov.**

A forma typica ita differt; *Folia* plerumque 4—nata, interdum verticillata. *Flores* umbellatae, 1—5 varians. *Corolla* ad maturitatem maxime inflata, rubro-rosea, venis rubris inconspiciuis; tubus 2·1 cm longus parvilobis 1·25 mm longis, late ovatis, obtusis, ad apices involutis et aliquantum fimbriatis sed non retusis. *Ovarium* anguste obovatum, longistipitatum.

Like the type except; *Leaves* mostly 4—nate, sometimes irregularly whorled. *Flowers* in umbels of 1—5 flowers. *Corolla* very much inflated at maturity, rose-red with inconspicuous veins; tube 2·1 cm long with small lobes 1·25 mm long, broad-ovate, obtuse, at the apices involute and somewhat fimbriate but not retuse. *Ovary* narrow-obovate, long-stipitate.

Flowering season, January to March.

CAPE—3419 (Caledon): Wet places on the Southern slopes of Babylon's Tower mountain c. 610—1066 m (—AD), January 1969 *L. Vogelpoel* s.n. (BOL 30673 holotype; isotypes NBG, PRE, STE); same locality, March 1939, *Stokoe* 9607 (BOL, NBG) and s.n. sub SAM 53663 (SAM); March 1939, *C. Thorne* s.n. sub SAM 53678 (SAM); 26 Feb. 1941, *Esterhuysen* 4961 (BOL, NBG). All the specimens cited have been examined by the author.

This variety is not so strikingly beautiful as that from which the species is named because the veins are less conspicuous against the darker corolla which is also shorter. Like *Erica turrisbabylonica*, described above, which has a near relative growing on Klein River Mts. nearby, *Erica aristata* grows in abundance on that range. In both instances, however, the flowering seasons are widely different i.e. spring on the Klein River Mts. and mid-summer to early autumn on Babylon's Tower.

ACKNOWLEDGMENT

The author wishes to thank Dr. L. Vogelpoel and Dr. W. P. U. Jackson for their assistance in obtaining living material and also the Curators of the Bolus and Compton Herbaria for allowing him to study material in their collections and for professional assistance from their staff.

NOTE ON THE VALIDITY OF *ERICA IONII*

*Erica ionii* H. A. Baker in JI S. Afr. Bot. **31**: 148 (1963) is now recognised by the author as being synonymous with *E. manifesta* Compton in JI S. Afr. Bot. **1**: 37 (1935).

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THE CORRECT APPLICATION OF THE NAME *TEPHROSIA DIFFUSA*

J. B. Gillett

(*East African Herbarium*)

***Tephrosia meyerana* Gillett** nom. nov.

Basionym. *Apodynomene diffusa* E. Mey., Comm. Pl. Afr. Aust. 113 (1836)

*Tephrosia diffusa* (E. Mey.) Harv. in Fl. Cap. 2: 210 (1861–2); H.M.L. Forbes in Bothalia 4: 1000 (1948) et auct. plur., non *T. diffusa* (Roxb.) Wight & Arn. in Wight Cat. 54 (1833); Prodr. Fl. Pen. Ind. Or. 1: 213 (1834).

The name proposed is in honour of E. Meyer, the first botanist to describe this interesting species.

## BYDRAE TOT DIE MORFOLOGIE EN ANATOMIE VAN ROMULEA:

### II. DIE BLARE

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#### SAMEVATTING

'n Vergelykende anatomiese studie van die blaarstruktuur van nagenoeg 50 Suid-Afrikaanse *Romulea*-species is gemaak. Die basiese blaarbou vir die genus is 'n bifasiale blaarskede en 'n lang smal terete unifasiale blaarskyf met vier lengteriwwe en altererend daarmee, vier huidmondjiedraende lengtegroewe. Deur verbreding van sekere riwwe en reduksie van ander het 'n aantal afgeleide blaartipes ontstaan. Sekere anatomiese kenmerke van die blaarstruktuur hang meestal saam met die verskillende knoltipes, bv. blare wat groot waterstorende epidermisselle, silindriese parenchimatiese vaatbundelskedes, en min sklerenchiem het, is geassosieer met knolle met 'n U-vormige of 'n sirkelvormige rif aan die basis; terwyl 'n kleinsellige blaarepidermis, onvolledige, U-vormige parenchimatiese bundelskedes en groot massas sklerenchiem teenaan die epidermis in die kostale streke, saam gaan met knolle wat aan die basis afgerond of gepunt is. Sulke kenmerk-kombinasies blyk van groot nut te wees om, saam met ander morfologiese en sitologiese kenmerke, die Suid-Afrikaanse romuleas in groepe in te deel.

#### ABSTRACT

**CONTRIBUTION TO THE MORPHOLOGY AND ANATOMY OF ROMULEA: II. THE LEAF.** A comparative anatomical study of the leaf structure of about 50 South African species of *Romulea* has been carried out. The basic leaf structure for the genus is a bifacial sheath and a long, narrow, terete, unifacial lamina with four longitudinal ribs and alternating with them, four stomatiferous grooves. Several derived leaf types developed through widening of certain ribs and reduction of others. Certain anatomical features of the leaf structure are generally correlated with the different corm types, e.g. leaves with large, water storing epidermal cells, cylindrical parenchymatous bundle sheaths and small amounts of sclerenchyma and corm with a U-shaped or a circular ridge at the base, occur together; while leaves possessing a small-celled epidermis, incomplete, U-shaped parenchymatous bundle sheaths and large masses of sclerenchyma against the epidermis in the costal zones, are correlated with corms with rounded or pointed bases. These combinations of characters, together with other morphological and cytological characters, are of great value in distinguishing groups of species in the South African romuleas.

#### INLEIDING

In die loop van die morfologiese ondersoek vir 'n hersiening van die Suid-Afrikaanse species van *Romulea*, het geblyk dat sekere anatomiese kenmerke, bv. van die knol en die blare, van aansienlike waarde sal wees vir 'n beter insig in die genus. In hierdie artikel word die blaarbou van ongeveer 50 species bespreek as voorafgaande studie tot die taksonomiese hersiening.

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Accepted for publication 5th February, 1970.

Béguinot (1907–09) het die blaaranatomie van *Romulea* belangrik beskou vir die taksonomie en het in sy monografie die blaarbou van ongeveer 30 Suid-Afrikaanse *Romulea*-soorte ingesluit. Daar hy vir die Suid-Afrikaanse spesies, behalwe vir *R. rosea* Eckl., slegs op herbariummateriaal aangewys was, en daar ná 1909 'n groot aantal nuwe spesies ontdek is met interessante blaarstruktuur wat in die taksonomie van nut blyk te wees, en ook weens die onbekendheid in die Republiek van sy werk, is die blaarbou by die Suid-Afrikaanse spesies verder ondersoek.

#### MATERIAAL EN METODES

Vars materiaal van die ongeveer 50 *Romulea*-spesies wat versamel is vanaf Namakwaland tot in Oos-Kaapland vir die sitotaksonomiese ondersoek, is ook gebruik vir die anatomiese ondersoek.

Die meeste blare is met die hand gesny, gekleur met safranien, en gemonteer in gliserienjellie. Dwarssneë is min of meer op die middelhoogte van 'n basale blaar gemaak, meestal die onderste een. By die paar spesies waar vars materiaal onverkrygbaar was, is herbariummateriaal gebruik wat in water gekook is om dit te laat uitdy. Verder is mikrotroomsneë, 15  $\mu$  dik, van die blare van verskeie spesies gemaak en met safranien en Delafield se hematoksilien gekleur en permanent gemaak.

Stukkies blaar is volgens Jeffrey se metode gemasereer om die aard van die sklerenchiem en die xileemelemente na te gaan. Die gewone mikrochemiese toetse vir selwande en kristalle is waar nodig uitgevoer.

Waar dit nodig is in die huidige werk, word 'n paar van die nuwe spesies met nog ongepubliseerde name genoem, met „n. sp. ms. nom.” daarby gevoeg. 'n Aantal van die seksies wat genoem word, is dié van Béguinot, t.w. die *Hirsutae*, *Hirtae*, *Roseae* en *Tortuosae*. Die beskrywings van die ander seksies asook van die nuwe spesies sal later gepubliseer word.

#### ONDERSOEK

Die romuleaplant besit, soos tipies vir die Iridaceae, 'n aantal blaartipes wat spirodistichies of soms distichies gerangskik is. Uitgesonderd die blomblare, kom die volgende blaarsoorte voor:

*Laagteblare (katafile)*. Die eerste blare wat elke groeiseisoen verskyn is een of twee, soms tot vier, regop, half-vliesige laagteblare wat 'n skede om die knol en die stingelbasis vorm en om dié rede *basale skedebblare* genoem kan word. Béguinot (1907 p. 83–84) onderskei hier tussen die „catafilli” of tunicae wat die knolomhulsel vorm en die „foglia vaginiformi”, skynbaar onbewus van die feit dat die basisse van die lg. die tunicae om die knol word.

'n Basale skedebblaar bestaan uit slegs 'n blaarskede en bly grotendeels



ondergronds behalwe vir sy top wat bo die grond mag verskyn en dan effens groen word. Dit ontwikkel vanuit 'n knoop aan die basale litteken van die knol (de Vos 1970). In sy onderste gedeelte wat die knol bedek, is dit geslote om die knoltunica te vorm. Sy anatomiese bou is eenvoudig, sonder groewe of riwwe, met 'n groot aantal parallelle are en met min huidmondjies. Die onderste gedeelte van daardie skedeblaar wat die „hoof”-tunica word, verbreed en aan die einde van die groeiseisoen verhout dit om die harde, gladde knoltunica te vorm.

'n Tweede tipe blaar wat ook onder laagteblare ressorteer, is die voorblaar (profiel) wat die eerste blaar van 'n sytak of ook sytak van die tweede orde is, en aangedruk teen die sytak en mediaan tussen die 1g. en die hoofas geleë is. Dit is 10—15 mm lank, 3—5 mm breed, en vliesig. Dit het dikwels 'n uitgerande top en is swak tweekielig met 'n aar in elke kiel. Volgens sommige is hierdie 'n aanduiding van sy ontstaan uit twee blare en volgens ander is dit teweeg gebring slegs deur drukking in die okselknop. Die voorblaar bevat soms nog enkele klein are behalwe die reeds genoemde twee. Huidmondjies kom selde voor en is aan die adaksiale kant in die buurt van die kiele geleë.

*Hoogteblare (hipsofile)*. Aan die top van elke bloeisteel direk onder die blom is 'n twee-kleppige spatha of bloeiskede, bestaande uit 'n skutblaar en 'n steelblaar of profiel (bracteola) wat die blomknop en later die ontwikkelende vrug beskerm. Sien onder bloeiwyse, in deel III van hierdie artikelreeks.

*Loofblare*. Van die knoop of knope aan die top van die knol, en by sommige spesies ook van die boonste van die groep knope by die basale litteken van die knol (de Vos 1970), ontwikkel een of twee, of selde drie, lang smal basale loofblare. Later ontwikkel daar ook 'n klein aantal loofblare van die knope op die bogronde stingel (stingelblare). Slegs by soorte met 'n verlengde stingel kan die stingelblare duidelik deur hul posisie en vorm van die basale loofblare onderskei word. By die soorte waar die stingel kort is, lyk al die loofblare basaal en byna eenders.

Die aantal basale loofblare is meestal konstant by 'n spesies, bv. één by *R. aquatica* Lewis, *R. flava* (Lam.) De Vos comb. nov. ms. en *R. georgensis* n. sp. ms. nom., en twee by die meeste spesies van die seksies *Hirsutae*, *Aggregatae*, en *Ciliatae*. Enkele spesies bv. *R. tabularis* Beg. het een of twee basale blare, en *R. dichotoma* Bak. wat meestal één basale blaar het, het sommige jong plante met twee, daar die boonste basale skedeblaar somtyds 'n verlengde blaarskyf besit. Dit toon die noue verband aan tussen hierdie twee blaartipes.

Die aantal stingelblare variëer van een tot vier of vyf. By sommige spesies is die aantal min of meer konstant, maar dikwels word dit ook beïnvloed deur die ouderdom van die plant en sy geilheid.

Die loofblare bestaan uit 'n bifasiale blaarskede wat geleidelik oorgaan in 'n unifasiale (isobilaterale ekwitante), meestal min of meer terete, filiforme

blaarskyf (fig. 1—3). By die meeste species beslaan die unifasiale gedeelte minstens die helfte van die lengte van die basale blare, maar by sommige species vorm dit slegs 'n derde of kwart van die blaarlengte, en by die seksie *Tortuosae* is die blaar bifasiaal tot ongeveer 10—15 mm vanaf die top. Die stingelblare, wat korter as die basale loofblare is, het 'n proporsioneel groter bifasiale blaarskede en korter unifasiale gedeelte. Die laasgenoemde deel is afwesig by die hoër stingelblare van sommige species en hier lyk die stingelblare dan skutblaaragtig.

Die unifasiale blaarskyf is 0.3—5 mm in deursnee en min of meer silindries of selde 4- of 8-vleuelig (fig. 3, 7, 9). Die hele blaaroppervlakte verteenwoordig die abaksiale kant van die blaar.

Die tipiese romuleblaarskyf het, soos reeds deur o.a. Béguinot (1907 p. 117) en Arber (1925) beskryf, vier lengteriwwe in die mediane en transversale vlakke en afwisselend daarmee, vier lengtegroewe. Die onderste mediane rif verteenwoordig die middelnerf van die blaar en die boonste die blaarrande (fig. 2, 3). Of die lengteriwwe deur verbreding in die mediane en transversale vlakke („dilatationswachstum”, Troll 1939 p. 1189) of deur „invaginations” in die diagonale vlakke (Arber 1925) ontstaan het, is onseker.

Die groewe wat al die huidmondjies van die blaarskyf bevat, is nie in staat om by waterverlies te sluit nie, maar bied waarskynlik 'n mate van beskerming aan teen oortollige transpirasie weens die betreklik windstille atmosfeer daarin.

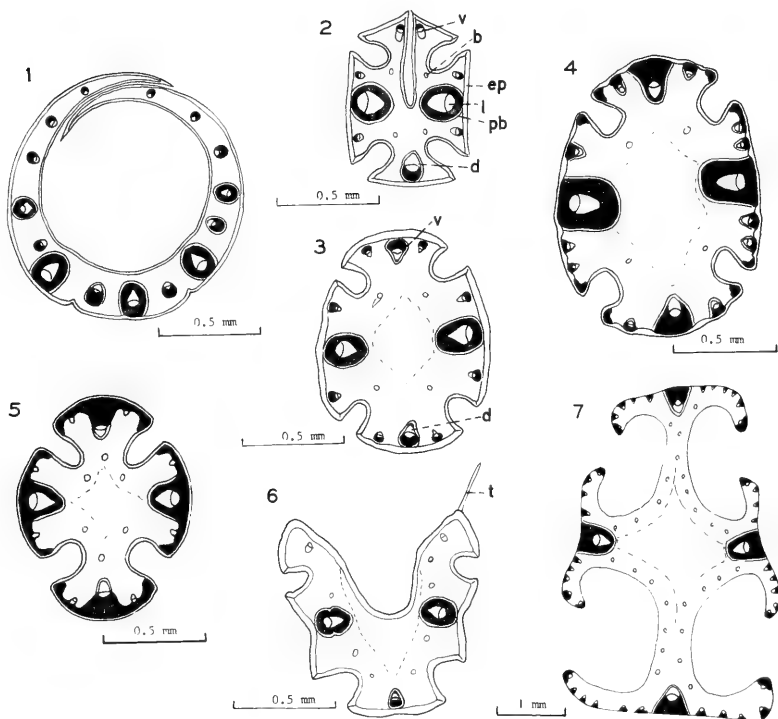
Nader na die blaarskede verdwyn die groewe en riwwe geleidelik. Die skede het 'n geringe aantal huidmondjies aan albei kante versprei.

'n Aantal species toon afwykende blaarbou wat van die tipiese bou afgelei kan word:

1. By *R. tortuosa* Bak. (fig. 6) is die blaar bifasiaal en konduplikaat tot 10—15 mm van die blaartop. Dit is vergelykbaar met die Europese *R. crocifolia* Vis. wat Arber (1921 p. 325) interpreteer het as 'n gereduseerde vorm wat gelyk is aan die blaarskedis van die ander species van die genus en waarvan die „petiolar limb” verlore is.

2. By *R. subfistulosa* De Vos is die blaar byna pypvormig met 'n amper oop kanaal in die senter en met breë groewe en riwwe waarvan die rande verbreed is tot agt lengtevleuels (fig. 7) wat veral prominent is wanneer die plant onder klam toestande gekweek word.

3. By *R. dichotoma* (fig. 11) is die twee laterale (transversale) riwwe tot 'n mate gereduseer en afgerond en bevat hulle slegs één vaatbundel elk. Die twee mediane riwwe is goed ontwikkel en vou dikwels gedeeltelik oor die laterale. By *R. hirta* Schlecht. en *R. tetragona* De Vos het die laterale riwwe byna geheel en al verdwyn. Die twee groewe weerskante is verenig om aan elke kant een



Dwarsneë deur loofblare van *Romulea*-species. Fig. 1, deur blaarskede van *R. dichotoma* op die hoogte waar die groewe begin vorm. Fig. 2, *R. flexuosa* op hoogte tussen blaarskede en skyf. Fig. 3–7, deur die blaarskyf: 3, *R. leipoldtii*; 4, *R. rosea*; 5, *R. sabulosa*; 6, *R. tortuosa*; 7, *R. subfistulosa*. Die xileem, floëem en bundelskede van die kleinste vaatbundels is nie apart getoon nie: b, klein vaatbundel sonder sklerenchiem; d, dorsale vaatbundel; ep, epidermis; l, hooflaterale bundel; pb, parenchimatiese bundelskede; t, trichoom; v, ventrale vaatbundel (randbundels).

wye groef te vorm. Die rande van die mediane riwwe is verbreed en vorm vier lengteveleuels wat die blaar in 'n dwarsneë X-vormig laat lyk (fig. 9). Die bg. drie species is nie nouverwant nie en hierdie tipe blaar het deur parallelle evolusie in die genus ontwikkel.

4. By die twee species van die seksie *Aquaticae* het die blare vyf tot agt groewe en netsoveel riwwe (fig. 10). Die ekstra groewe het in die middel van die vier oorspronklike riwwe ontwikkel of, waar daar net een of twee ekstra groewe is, in die laterale riwwe. Hierdie is waarskynlik 'n aanpassing aan die water-

habitat van die spesies om, d.m.v. 'n groter aantal huidmondjies, 'n verhoging van die transpirasie te verkry.

5. By *R. cruciata* (Jacq.) Bak. wat besonder breë groewe het, ontwikkel soms 'n uiters smal lengteriffie wat grotendeels uit 'n sklerenchiembundel bestaan, in die middel van elke groef (fig. 8). 'n Dwarssneetekening van so 'n blaar vir *Ixia cruciata* (Jacquin 1786—93) het tot 'n mate van verwarring gelei, omdat dit tot kort gelede nie weer teruggevind kon word onder die romuleas nie. Dit is 'n nie-konstante kenmerk by *R. cruciata*.

*Die are.* Sonder uitsondering kom in die middel van elke lengterif 'n groot vaatbundel voor. Dit is omring met 'n sklerenchiemskede wat soms aan die kante onderbreek is, en by die twee mediane are ook dikwels aan die binnekante. Die dorsale bundel in die mediane rif wat die middelnerf van die blaar is, is kleiner as die twee laterale bundels in die transversale riwwe (d en l in fig. 2). Die mediane are in die agterste rif, die ventrale bundel genoem, stel die twee randbundels van die blaarskede voor (v in fig. 2, 3).

Waar die blare ongeveer een millimeter in deursnee of breër is, kom meestal een of twee klein vlak geleë vaatbundels met klein sklerenchiemkappies weerskante van die grotes voor. Hul aantal varieer by sommige spesies en ook op verskillende hoogtes van die blaar. Ook is daar een of twee klein vaatbundels meestal sonder sklerenchiem diep in die mesofil teenoor elke groef geleë. Anastomoses kom hier en daar voor.

By sekere seksies, bv. die Atrandrae, Bicarinatae, Roseae, ens. is die sklerenchiemskedes om die groot are massief en oor hul hele breedte in kontak met die epidermis. By enkele spesies bv. *R. sabulosa* Beg., *R. monadelpha* Bak. het die sklerenchiem van al die vaatbundels in 'n rif verenig om 'n aaneenlopende subepidermale sklerenchiemlaag oor die hele rif te vorm (fig. 5). Hierdie massiewe sklerenchiemskedes bevat baie vesels met sterk-verdikte verhoude selwande en min prosenchimatiese verhoude parenchiem.

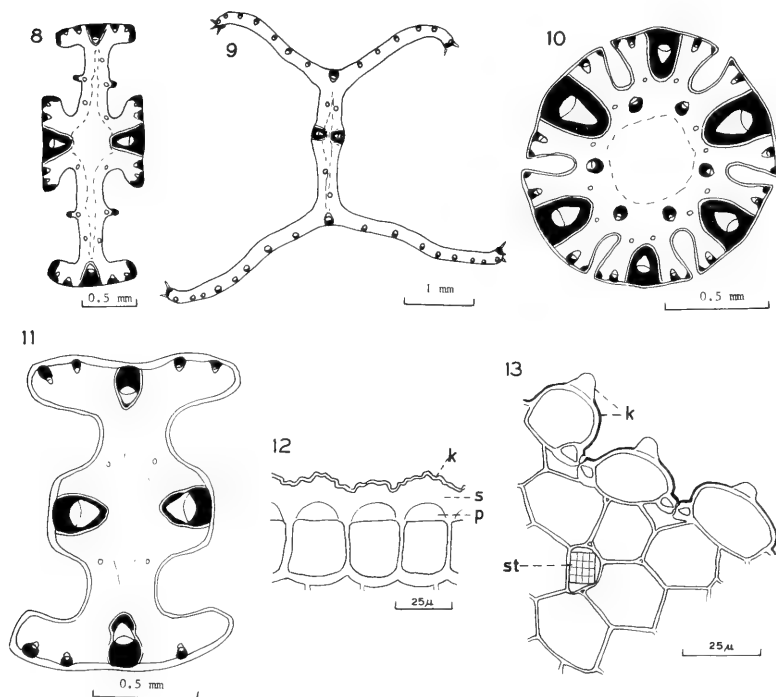
By die seksies Hirsutae, Ciliatae, Tortuosae, ens. is die sklerenchiemskedes dikwels kleiner en bevat hulle minder vesels en meer prosenchimatiese verhoude parenchiem. Hulle is meestal van die epidermis geskei deur een of twee lae kleurlose dunwandige parenchiem (fig. 14). In ouer blare van sommige spesies is daar 'n neiging vir hierdie parenchiemselle om te verhout en so tot die sklerenchiemskede bygevoeg te word.

Parenchimatiese bundelskedes kom voor rondom die sklerenchiemskedes. Hulle is sonder of byna sonder chloroplaste, is één sellaaq breed, en goed ontwikkel veral teenoor die xileem. By die seksies met betreklik klein sklerenchiemskedes wat nie tot teen die epidermis strek nie, is die parenchimatiese bundelskedes silindervormig (sirkelvormig in dwarssnee) (fig. 3, 14) en bevat dit selrye met styloiede van kalsiumoksalaat. By die spesies met 'n groot sklerenchiemskede

rondom die vaatbundel, vorm die parenchimatiese bundelskede 'n onvolledige silinder wat U-vormig in dwarsnee is, met die twee arms van die U weerskante vas teen die epidermis (fig. 4, 15). Hier kom dikwels geen styloïede in die skede voor nie, behalwe by 'n paar spesies soos *R. rosea* Eckl. en *R. subfistulosa*, waar styloïede in die subepidermale selly aan weerskante aanwesig is.

Die vaatbundels in die blare van *Romulea* behoort aan die primitiewe tipe I monokotielbundels van Cheadle en Uhl (1948a), d.w.s. met die groter metaxileemelemente min of meer eenders in grootte en met die xileem in 'n effens geboë lyn teen die floëem geleë.

Die laat metaxileemelemente by *Romulea* is slegs tracheïede. Gemasereerde blare toon dat die tracheale elemente van die vroeë metaxileem en die laat



Dwarssnê deur loofblare van *Romulea*-spesies: Fig. 8, *R. cruciata*. Fig. 9, *R. tetragona*. Fig. 10, *R. aquatica*. Fig. 11, *R. dichotoma*. Fig. 12, *R. sphaericarpa*, epidermisselle van die blaarrif, met pektienryke stroke onder die selluloselaag. Fig. 13, *R. monadelphica*, huidmondjies en papildraende epidermisselle in die blaargroewe; k, kutikula; p, pektienryke stroke; s, selluloselaag; st, styloïed.

protoxileem, wat weens hul wydte (15—20 $\mu$ ) in dwarsnee as tracheae beskou kon word, ook tracheïede is, meestal leertracheïede in die metaxileem en spiraal-, soms ringtracheïede in die protoxileem. Nêrens kon perforasieplate waargeneem word nie. Hierdie bevinding stem ooreen met Cheadle (1963) se ondersoek vir ander genera van die Iridaceae. Die tracheïede is verskeie millimeter lank, met lang punte wat geleidelik smaller word.

Die metafloëem hoort tot die intermediêre monokotieltype wat dikwels in die tipe I vaatbundel voorkom (Cheadle en Uhl 1948b). Dit het sifbuisse met slegs klein verskille in grootte, en die begeleidende selle is nie in 'n besonder reëlmatige patroon gerangskik nie (fig. 14, 15).

*Die epidermis.* Die huidmondjies wat slegs in die groewe voorkom, is in groot getalle en effens ingesink. In die basis van 'n groef wissel 'n huidmondjie en 'n gewone epidermissel mekaar reëlmatig af, sodat dáár net soveel huidmondjies as gewone epidermisselle aanwesig is (fig. 13). Die laasgenoemde is egter baie langer as die sluitselle. Hulpstelle is afwesig (vgl. Stebbins en Khush 1961).

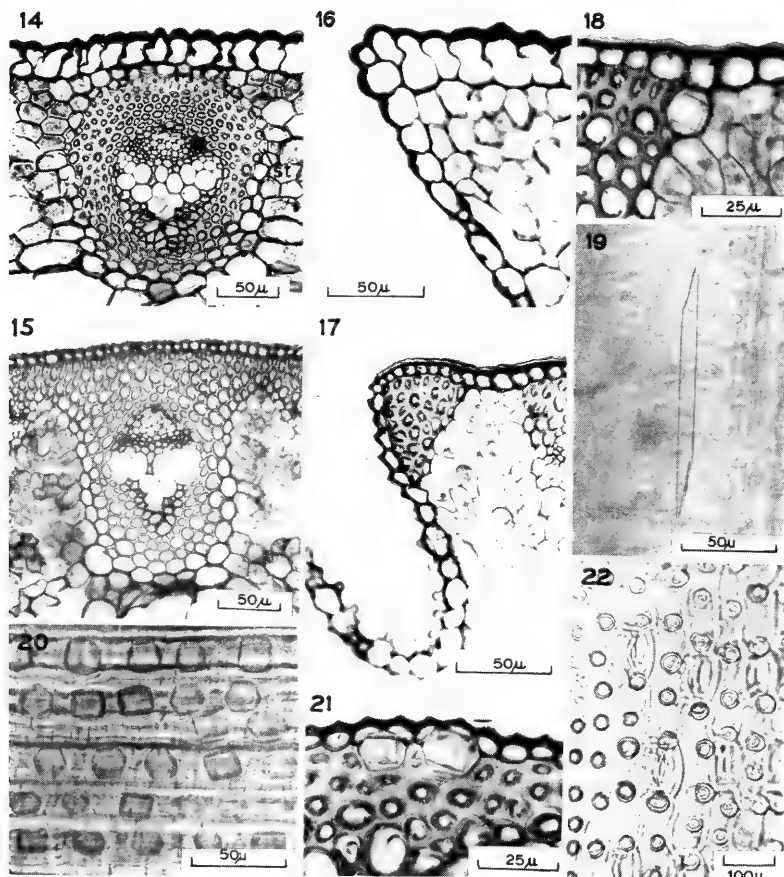
By die seksies Aquaticae, Minutiflorae, Pratenses, meeste spesies van die Roseae en Atrandrae, en verskeie Ciliatae, kom kort epidermale papille op al die gewone epidermisselle in die groewe voor. Hulle lê meestal in 'n enkele ry op 'n sel (fig. 22) en hul getalle varieer van twee tot tien per sel vir die genus, maar in 'n bepaalde spesies is die variasie kleiner. Elke papil is 'n soliede selwandverdikking wat oortrek is met 'n dun kutikula (fig. 13, 17). Op die blare van *Sisyrinchium* het Linsbauer (1930) soortgelyke epidermale papille gevind.

Die funksie van die papille is moontlik om ligstrale te versterk of miskien selfs te fokus op die onderliggende mesofil selle. Wanneer die mikroskoopkondensor na onder gedraai word om die mikroskoopveld te verdonker, skyn 'n skerp ligkolletjie deur elke papil, wat nogal baie lyk soos in die foto's van Haberlandt (1928 p. 619). Die papille kom voor by baie spesies met smal groewe maar ook by sommige met wye groewe. As 'n mens aanneem dat hul funksie is om lig te versterk, sou afgelei kan word dat die wyer groewe 'n latere ontwikkeling is wat tot stand gekom het by spesies met papille en ook by spesies sonder papille.

Béguinot (1907 p. 117—119) het aan die hand gedoen dat die papille tot 'n mate 'n hulpmiddel is om die transpirasie by xeromorfe soorte te bemoeilik en om wateringang by die higromorfe soorte te verhinder.

Die blaariwwe kan op grond van hul epidermis in twee groepe verdeel word:

1. Met 'n grootsellige (ca. 25—60 $\mu$  hoog), betreklik dunwandige, waterstorende epidermis (fig. 12, 16), by die seksies Ciliatae, Hirsutae, Macowania, en Tortuosae. Die antiklinale selwande is besonder dun, die binne-periklinale wande effens dikker, en die buitewande die dikste, 6—10 $\mu$  dik. Die kutikula



*Romulea*-blaarweefsels. Fig. 14, hooflaterale vaatbundel van *R. montana*. Fig. 15, hooflaterale vaatbundel van *R. rosea* var. *reflexa*. Fig. 16, dwarsnee deur rifrand van *R. montana*, sonder sklerenchiem. Fig. 17, dwarsnee deur rifrand van *R. rosea* var. *reflexa*, met sklerenchiem versterk en met papillae in die groef. Fig. 18, subepidermale styloied in dwarsnee by *R. rosea*. Fig. 19, styloied in die lengte in die mesofil by *R. longipes*. Fig. 20, paradermale snee van die kostale streek van *R. atrandra*, met kort subepidermale kristalle. Fig. 21, dwarsnee deur 'n kostale streek van *R. sabulosa* met kort subepidermale kristalle. Fig. 22, paradermale snee van die blaargroef van *R. gigantea*, met papildraende epidermisselle en huidmondjies. st, styloied.

egter is meestal slegs 1—2 $\mu$  dik en die sellulosewandlaag daaronder 5—8 $\mu$ . Die kutikula het 'n skurwe of hobbelrige voorkoms of 'n sentrale ophewing in

die middel van elke sel (fig. 12). By verskeie spesies bestaan die selluloselaag onder die kutikula uit twee lae: waarskynlik 'n pektienarme en 'n pektienryke laag (fig. 12), wat by *R. sphaerocarpa* n. sp. ms. nom. met uitdroging tot die helfte van sy dikte krimp.

By *R. sphaerocarpa* word slym op die blaarriwwe in die jong stadium uitgeskei waaraan sandkorrels vaskleef en wat later droog word. Die slym word ligpienk gekleur met ruteniumrooi, bly kleurloos in chloorsinkjodium, en is waarskynlik 'n pektienslym. Waarvandaan dit afkomstig is en hoe dit uitgeskei word, is onbekend. Geen slymselle of kanale is onderskeibaar nie en, behalwe vir 'n uiters dun kutikula van ongeveer  $1\mu$ , kom geen strukture voor wat nie ook in ander spesies aanwesig is nie. Die baie jong blaar sal hier ondersoek moet word.

2. Met 'n kleinsellige, na verhouding dikker-wandige epidermis (fig. 15, 17), by die seksies Atrandrae, Bicarinatae, Hirtae en Roseae. In die kostale streke is die epidermisselle ongeveer  $6-12\mu$  hoog en, alhoewel hulle teen die vaatbundelsklrenchiem lê, is hulle nie verhout nie, behalwe by *R. eximia* n. sp. ms. nom. In die interkostale streke is die epidermisselle meestal dubbeld so groot.

Die buite-selwande is, soos by die grootsellige epidermis, meestal ongeveer  $6-8\mu$  dik, waarvan die kutikula  $2-4\mu$  beslaan. Die kutikula is dus effens dikker, maar die buitewande as geheel is slegs in verhouding tot die selhoogte dikker as by die eerste groep. By enkeles, bv. *R. subfistulosa* en *R. campanuloides* Harms is die buitewand tot  $12\mu$  dik en beslaan dit die helfte van epidermissel-hoogte.

'n Epidermis met 'n selgrootte tussen dié van die groot- en kleinsellige epidermistipes, kom voor in die seksies Aggregatae, Pratenses en Aquaticae, en by *R. minutiflora*.

*Die rifrande.* By die meeste spesies met 'n grootsellige epidermis word die rande van die lengteriwwe gevorm deur die skerpgevoude epidermis, sonder enige versterkingsweefsel daarby (fig. 2, 3, 6, 16). By die seksies met afgeronde of gepunte knolbassis, asook by die Minutiflorae en enkele spesies van die Ciliatae is die rifrande van die blaar afgerond en sonder 'n skerp vou in die epidermis. Hierdie rande is versterk met 'n subepidermale bundel verhoue sklerenchiem (vesels) wat skynbaar uit die mesofil ontwikkel het (fig. 4, 5, 7, 8, 10, 17). By die Atrandrae en sommige van die Bicarinatae is 'n klein vaatbundel met hierdie veselbundels geassosieer (fig. 7). Hierdie kenmerk is van belang om die seksies uit te ken.

'n Paar spesies, bv. *R. amoena* Beg., *R. albomarginata* n. sp. ms. nom., het die rifrande versterk met 'n bundel onverhoue, maar dikwandige selle afkomstig van die epidermis, wat dáár multiseriaal geword het. Hierdie spesies is nie naverwant nie.



Sekere species o.a. *R. hirsuta* Bak., *R. hirta*, *R. tortuosa*, *R. tetragona* en *R. dichotoma* wat wydversprei is onder verskillende seksies, het dikwels 'n ry eensellige, kort of lang hare op die rifrante (fig. 6, 9). Hierdie kenmerk, wat aan twee van die bg. species hul name besorg het, is by sommige species nie konstant nie en in baie versamelings kom behaarde asook naakte blare voor.

*Die mesofil.* Die sentrale gedeelte van die silindriese blaar is ingeneem deur 'n klompie groot, dunwandige, kleurlose selle wat dikwels vervorm en gedeeltelik verskeur is. Die groot vaatbundels in die middel van elke rif strek meestal tot teenaan hierdie kleurlose mesofil, en daardeur word die groen mesofil in vier massas verdeel, elk vanaf die een groot bundel onder die groef deur tot die volgende groot bundel (fig. 4). By enkele soorte, bv. *R. sabulosa*, met 'n aaneengeslote subepidermale laag sklerenchiem oor die hele breedte van 'n rif, is die chlorenchiem slegs onder die groewe in aanraking met die epidermis (fig. 5).

In 'n dwarsnee word baie min intersellulêre ruimtes in die mesofil gesien, maar lengtesneë toon die chlorenchiemselle in dwarslae, dikwels van mekaar geskei deur smal intersellulêre ruimtes. Hierdie dwarslae van mesofilselle ontstaan tydens die ontwikkeling wanneer die blaar verleng en die selverlenging nie met die verlenging van die blaar kan tred hou nie. Die chlorenchiemselle is gewoonlik ovaal en nie in spons- en palissadeweefsel verdeel nie.

*Kristalle.* Twee vorms van kristalle kom voor:

1. Lang spiesvormige styloïede van kalsiumoksalaat-monohidraat (vgl. Netolitsky 1929, Frey 1929) kom versprei voor in die mesofil van nagenoeg al die ondersoekte soorte (fig. 19). By die seksies met groot epidermisselle en silindervormige vaatbundelskedes kom styloïede ook in die bundelskedes voor, veral langs die kante van die groot bundels (fig. 14). By die *Roseae* en twee species van die *Atrandrae* is styloïede subepidermaal geleë, in die hoeke wat die bundelskedes met die epidermis vorm (fig. 18). Hulle kom enkeld voor in lang smal dunwandige selle wat in lengterye en parallel met die lang as van die blaar lê.

Die styloïede is 80—180 $\mu$  lank, spitspuntig, en stel die sg. *Liliaceae* styloïed-tipe voor (Netolitsky p. 62). Soms het een punt 'n swaelstertkeep of lyk dit onreëlmatig verbrokkel. In dwarsnee is die styloïed vierkantig of reghoekig, 5—10 $\mu$  by 5—8 $\mu$  en in water gemonteer lyk dit geruit, met 12—20 klein vierkantjies dofweg daarin onderskeibaar (fig. 13). Dit verval egter nie in rafides nie maar is 'n enkele eenheid.

Die styloïede is vergelykbaar met dié van *Crocus*, *Gladiolus* en *Iris*—by *Iris* egter is hulle 0.1—0.6 mm lank (aangegee deur Netolitsky).

2. In sekere seksies met bundelskedes sonder styloïede, t.w. die *Atrandrae*, *Autumnales*, *Bicarinatae*, en *Hirtae*, kom kort, byna isodiametriese of effens verlengde kalsiumoksalaatkristalle subepidermaal voor in die kostale streke

van die groot vaatbundels (fig. 20, 21). Hulle is 16—25 $\mu$  lank en lê ook enkeld in dunwandige idioblaste wat baie korter is as die aangrensende sklerenchiemvessels en epidermisselle. By die meeste spesies is hulle byna vierkantig in dwarsnee en vertoon hulle óf seskantig óf reghoekig in hul lengte. Hulle behoort waarskynlik aan die orto-rombiese kristalstelsel. Hulle stem egter nie ooreen met enigeen van die kristalfigure wat Frey (1929) aantoon nie en daar kon nie vasgestel word of hulle van die mono- of trihidrate kalkoksalaat is nie. By *R. monadelphæ* vertoon hulle dikwels seskantig in 'n dwarsnee van die blaar en hier lê hulle moontlik dan met hul vertikale asse dwars in die selle.

Hierdie kort kristalle is naasteby soos dié in die *Romulea*-knoltuniciæ (de Vos 1970), waar hulle egter meer algemeen voorkom, ook by spesies wat nie sulke kristalle in die loofblare het nie.

#### BESPREKING

Die *Romulea*- en *Crocus*-blare verskil heelwat van mekaar. Die *Crocus*-blaar is bifasiaal met die randbundels vër van mekaar geleë en meestal met slegs twee groewe wat die paar groewe weerskante van die middelaar van *Romulea* voorstel (Arber 1925).

Die blaarbou van die ongeveer 28 *Romulea*-spesies van die noordelike halfgrond wat deur Béguinot (1907–09) ondersoek is, varieer baie minder as dié van die Kaapse soorte: al die noordelikes het byvoorbeeld sklerenchiembundels op die rifrande. Die byna konstante blaarbou stem ooreen met die konstante knolbou van die *romuleas* van die noordelike halfgrond.

Béguinot (1907 p. 117—120) het die xeromorfe en higromorfe blaarkenmerke van die *Romulea*-spesies sterk beklemtoon. Onder xeromorfe kenmerke het hy genoem die kleinsellige, dikwandige epidermis, die vele vaatbundels met sterk-ontwikkelde sklerenchiemskedes styf teen die epidermis geleë, en die sklerenchiembundels in die rifrande. Sy higromorfe kenmerke is die hoë epidermisselle met swak verdikte buitewande en dun binnewande, die aanwesigheid in sommige spesies van 'n subepidermale laag wat water opberg (wat nie in die huidige ondersoek teruggevind is nie), minder vaatbundels geskei van die epidermis deur een of meer dunwandige sellae en omring met 'n minder-verhouete, dikwels onvolledige sklerenchiemskede, en die aanwesigheid van hare op die rifrande.

Dit is onseker of die kenmerke deur Béguinot onderskeidelik as xeromorf en higromorf beskou, werklik aan die plante die vermoë verleen om meer of minder droogte-bestand te wees. Op die Stellenbosch-vlakte groei soorte met sg. xeromorfe en ander met higromorfe kenmerke bymekaar. In die Karoo staan *R. austinii* Phill. met higromorfe blaarkenmerke, en *R. atrandra* Lewis met xeromorfe kenmerke op plekke wat ewe droog lyk. Daar sal meer ondersoekingswerk gedoen moet word om te bepaal of Béguinot se sienswyse aanvaarbaar is.

Béguinot was verder van mening dat die xeromorfe blaarkenmerke die oorspronklike vir die genus is en die higromorfe kenmerke 'n meer resente verwerwing verteenwoordig. Wanneer die blaarkenmerke egter saam met ander kenmerke, bv. die knolkenmerke en die stingellengte beskou word, wil dit voorkom asof die teenoorgestelde die geval is, en die higromorfe kenmerke primitief is. Hulle kom voor saam met primitiewe knolle met 'n halfmaan-vormige basale dwarsrif, en met verlengde stingels wat as meer primitief beskou word as die kort stingels wat algemeen voorkom by die spesies met die sg. xeromorfe kenmerke.

Goebel (1928 p. 372–74) en Troll (1939 p. 1179–80) het aan die hand gedoen dat die silindriese unifasiale blaar 'n verder ontwikkeling is van die voorloperspits wat aan die top van vele monokotielblare aanwesig is as 'n kort rolronde spits puntjie. Deur die blaarontwikkeling na te gaan, het Thielke (1949) die bewys gelewer dat die voorloperspits en die unifasiale blaargedeelte homoloog is in hul ontwikkeling en dat albei uit 'n sg. sekondêre meristeem ontstaan wat abaksiaal van die eerste meristeem ontwikkel.

By *Romulea* vind 'n soortgelyke ontwikkeling plaas: die jong, pasverskene blaarprimordium buig met sy rand soos 'n monnikskap oor die stingelgroei-punt, en van die top van die kap, d.w.s. taamlik abaksiaal, groei 'n terete uitstulping opwaarts (die sekondêre meristeem van Thielke) wat die unifasiale blaarskyf vorm, terwyl die bifasiale eerste blaarprimordium (die „monnikskap”) tot blaarskede ontwikkel. Die verskillende lengteverhoudings van unifasiale blaarskyf en bifasiale skede by die verskillende *Romulea*-spesies en by die verskillende blare op 'n romuleaplant is te wyte aan die relatiewe hoeveelheid van interkalêre lengtegroei in die twee gedeeltes van die blaarprimordium. By *R. tortuosa* byvoorbeeld, met die unifasiale gedeelte slegs 10–15 mm lank, is daar net 'n geringe lengtegroei in die rolronde deel. Dit is nie noodwendig 'n gereduseerde blaar, soos Arber (1921) die soortgelyke blaar van *R. crocifolia* beskou het nie.

Die belangrikste bevinding van die huidige ondersoek, wat van belang sal wees vir die taksonomie, is dat daar meestal 'n korrelasie voorkom tussen die verskillende knoltipes en blaarstrukture—iets wat te verwagte is aangesien die knoltunicae deur die blaarbasisse gevorm word.

By voorbeeld, knolle met 'n hoefvormige of sirkelvormige basale rif met parallelle fibrille daarop, is meestal geassosieer met blare met 'n grootsellige, proporsioneel dunwandige epidermis, en vaatbundels, dikwels slegs één per lengterif, omring met betreklik klein sklerenchiemskedes wat meestal nie teen die epidermis lê nie, en silindervormige parenchimatiese bundelskedes daaromheen, waarin meestal spiesvormige styloïede voorkom. Die rande van die lengteriwwe is, met enkele uitsonderings, sonder sklerenchiembundels. Hiertoë behoort die seksies Ciliatae, Hirsutae, Tortuosae en Macowania.

Aan die ander kant, plante met 'n afgeronde of gepunte knolbasis besit

blare met 'n kleinsellige, na verhouding dikker-wandige epidermis, en vaatbundels, meestal meer as een per lengterif, omring met groot massiewe sklerenchiemskedes wat breed teen die epidermis lê, en met onvolledige U-vormige parenchimatiese bundelskedes daaromheen wat sonder styloïede is behalwe soms in die subepidermale posisies weerskante. Die rande van die lengteriwwe is met sklerenchiembundels versterk (een uitsondering) en dikwels kom kort kristalle subepidermaal voor in die sklerenchiem van die kostale streke (seksies *Atrandrae*, *Autumnales*, *Bicarinatae*, en *Hirtae*). Hiertoe behoort die genoemde vier seksies asook die *Roseae*.

'n Derde groepie bestaande uit die *Aggregatae* en *Amoenae*, besit knolle met klein groepies fibrille op die basale riwwe en blare met 'n epidermis min of meer tussen die bogenoemde twee, vaatbundels teen die epidermis geleë of een sellaaag weg, en met die lengterifrante sonder sklerenchiem maar soms met 'n multisellulêre dikwandige epidermis versterk.

Enkele uitsonderings, waar die bogenoemde korrelasies nie voorkom nie, is: 'n paar spesies, bv. *R. minutiflora* en *R. aquatica*, het blare met die rifrante versterk met sklerenchiem, volledige of onvolledige parenchimatiese bundelskedes, epidermisselle van mediumgrootte, en knolle met basale riwwe.

Die papille in die blaargroewe is, sover vasgestel kon word, konstant in die spesies waar hulle voorkom. Hulle is aanwesig in aldie die bogenoemde groepe. Enkele seksies het sommige spesies met papille en ander daarsonder. Dit lyk dus asof papille verskeie kere onafhanklik in die genus kon ontstaan het—of, as hulle in die hele genus aanwesig was, verskeie kere kon verdwyn het.

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## A NEW SPECIES OF HAWORTHIA FROM THE EASTERN CAPE

C. L. Scott

### ABSTRACT

The description of a new species, *Haworthia springbokvlakensis* Scott, now clarifies a misinterpretation, which has persisted for many years whereby this species was confused with and referred to as *H. retusa* var. *mutica*. (Haw.) Bak.

A key is provided for the taxa dealt with.

### UITTREKSEL

'n NUWE HAWORTHIA SOORT VAN DIE OOS KAAP. Die beskrywing van die nuwe spesie, *Haworthia springbokvlakensis* Scott, verskaf nou 'n opklaring van die verkeerde uitleg en verwarring van die spesie *H. retusa* var. *mutica*. (Haw.) Bak.

'n Sleutel vir die taksa bespreek, word voorsien.

### INTRODUCTION

According to available records the locality of the new species has been known since 1932, where it has been collected at a locality close to the farm Springbokvlakte and generally known by the name of *H. retusa* var. *mutica*.

In the protologue in Feddes Rep. 43:105(1938) Von Poellnitz refers to *H. retusa* var. *mutica* as occurring on the Springbokvlakte near Steytlerville in the eastern Karoo, and this reference is probably the reason for the confusion.

Recent research and revision of the Genus *Haworthia*, has revealed that there is no affinity between *H. mutica* and *H. springbokvlakensis* as revealed by the following historical notes.

Bowie who first collected *H. mutica* Haw. left Cape Town on his first collecting journey eastwards on the 23rd March, 1818, and returned to Cape Town on the 14th January, 1819. He followed the route to Caledon, George, Plettenberg Bay and up to Avontuur and it is most probable that he collected *H. mutica* in the vicinity of Mossel Bay.

With our present knowledge of the distribution of plants in the Mossel Bay district, we can be readily certain that the later gatherings must have been in the same vicinity where in 1818 he collected *H. mutica*. It is confined to a restricted area and as far as present records serve, the species is only known to occur in the Mossel Bay district.

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Accepted for publication 17th June, 1970.

### KEY TO THE SPECIES DEALT WITH

- b End area of leaf tubercled, about 18 mm broad, 4-5 lines, back of leaf tubercled.  
*H. springbokvlakensis.*

*Rosetta acaulescens*, 7 cm diam. *Folia* 7—9 recurvata ad 37 mm longa, 18 mm lata, 4 mm crassa, per 90° recurvata; *parte retusa* convexa 17 mm longa, plana lineis 4—5 brevibus et longis valde reticulatis ornata; *subtus* apicem versus tuberculis; *carina* *marginisque* minime denticulati.

*Rosette* acaulescent, about 7 cm diam., not proliferous from the base. *Leaves* 7–9, spreading, positioned in 3 indistinct rows, recurved, firm, about 37 mm long, up to 18 mm broad, and 4 mm thick at the base of the end area, oblong, ovate; *face below end area* concave the full face length, three-quarter of leaf reddish brown, remainder towards base of leaf yellowish green; *end area* 17 mm long, 18 mm broad, convex, beset with minute concolorous tubercles, with a few oblong, longitudinally arranged whitish flecks, pellucid, reddish, with 4 long and 5 short very reticulate brown lines none reaching the apex, retused at an angle of about 90 degrees; *back* convex, smooth below, minutely tuberculated in the upper third, dull, with about 15 indistinct greenish reticulated parallel lines; *keel* central 1 in upper third, present only in some leaves, whilst the other leaves have a rounded keel which is obliquely arranged near the margins, resulting in the distortion of the spherical angle of the retused area; *margins* acute, below,  $\pm$  rounded above, the  $\frac{1}{2}$  mm-long, pellucid teeth becoming minute towards the base of the leaf. *Peduncle* simple, 2 mm in diam. and up to 33 cm long, including the raceme, greyish green; *sterile bracts* about 20, 6 mm long, the lowest 10 mm from the base of the peduncle; *raceme* up to 16 cm long, 35 spirally arranged flowers and buds, 2 open simultaneously; *fertile bracts* 4 mm long, deltoid acuminate, white with a fine dark brown nerve; *sterile bracts* 12, up to 5 mm long, white, with reddish brown nerve; *Pedicels* 3 mm long, 1 mm in diam., dark green; *perianth* white, 14 mm long, the cylindrical triangular base swelling 4 mm in diam., constricted to 3 mm above,



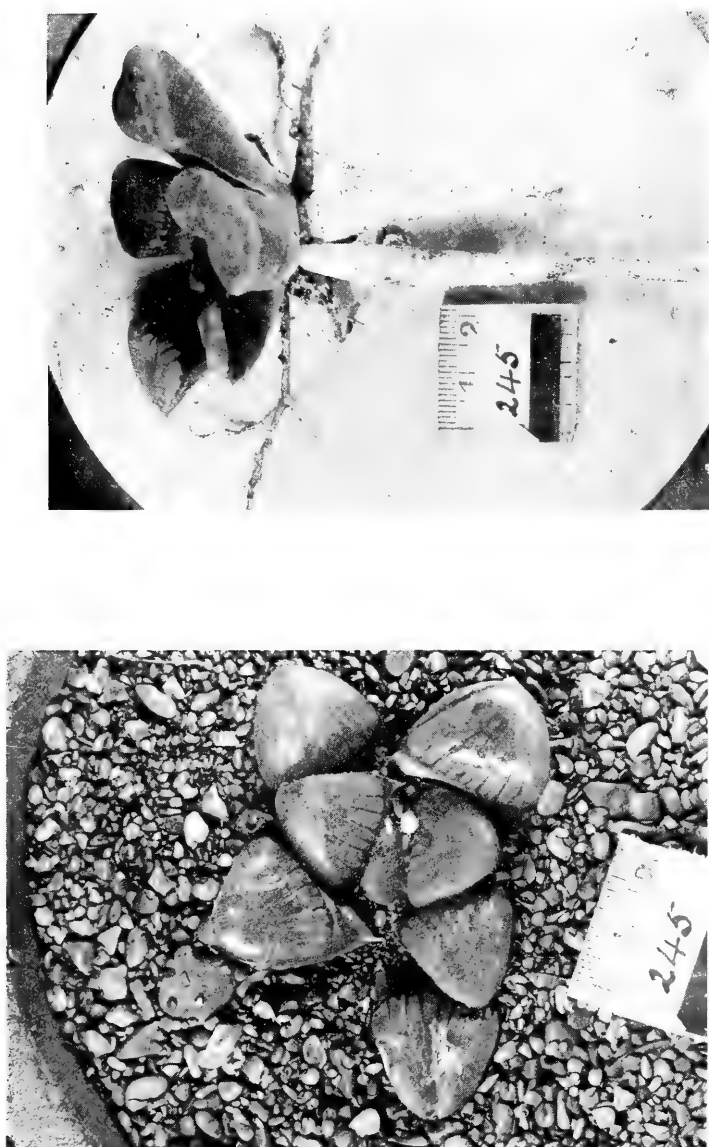


FIG. 1. *Haworthia springbokvlakensis* Scott.

ascending, not, or hardly, curved; *upper segments* straight, tips slightly recurved, channelled, face colour of inner segment pinkish white with a broad brown nerve, narrow, obtuse, green below, face colour of the two outer, pinkish white, with a fine brown nerve, acute; *lower segments* very recurved, face colour of inner segment pinkish white, with a fine brown nerve, channelled, narrow, obtuse, face colour of two outer segments, white with a broad brown nerve, deeply channelled, spreading, green below; *Stamens* 5 and 6 mm long; *Style* white, 1 mm long, bent capitate; *ovary* 4 mm long, 2 mm diam., dark green. *Habitat*: CAPE, 3324 BD (Steytlerville). Type *C. L. Scott* 245 (PRE!, holo.). *Distribution*: not further known.

The species is described from material collected by the Author on the farm Springbokvlakte at an altitude of  $\pm 19$  meters in the Uitenhage District, where it grows level or partly submerged in the ground, usually in exposed conditions and withdrawing completely during the hot summer months.

As far as present records serve it is confined to a restricted area and known only to occur at two other localities a few kilometers further east of the farm Springbokvlakte. This is the easternmost locality on record for the *Retusae* family.

The species is characterised by the irregular form of the plants, which is due to its acutely keeled end area. Its true relationship is not altogether clear as it does not resemble any described species in the Sect. *Retusae*.

## THE IRIDACEAE OF DANIEL DE LA ROCHE

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and T. T. Barnard

### ABSTRACT

A study of the thesis *Descriptiones Plantarum Aliquot Novarum* by Daniel de la Roche was undertaken with a view to establishing the identity of the 20 species of South African Iridaceae which were described. It was found that all but one species were in fact new. Owing to the lack of type material or the nature of the specimens three of these could not be matched with known plants. Some species had been seriously misunderstood and several taxonomic changes were accordingly made.

### UITTREKSEL

DIE IRIDACEAE VAN DANIEL DE LA ROCHE: Die tesis, *Descriptiones Plantarum Aliquot Novarum*, deur Daniel de la Roche is bestudeer om die identiteit van 20 Suid-Afrikaanse Iridaceae soorte wat daarin beskryf word, vas te stel. Daar is gevind dat almal, met die uitsondering van een, nuwe soorte is. As gevolg van die gebrek aan tipemateriaal of die toestand van die eksemplare kon drie soorte nie met bekende soorte vergelyk word nie. Blykbaar was daar groot misverstand by sommige soorte en verskeie taksonomiese wysigings is as gevolg hiervan aangebring.

### INTRODUCTION

In 1766 Daniel de la Roche's doctoral thesis, entitled *Descriptiones Plantarum Aliquot Novarum*, was published at Leiden. This thesis, supervised by David van Royen of Leiden University, contained what were believed to be descriptions of 20 South African species new to science. Fourteen of these were referred to *Ixia*, three to *Gladiolus* and the last three to de la Roche's new genus *Vieusseuxia*, which is today regarded as a subgenus of *Moraea*. The significance of de la Roche's work has been considerably underestimated. The thesis was dismissed by Hutchinson (1946) as a small paper of little importance. It must be pointed out that, on the contrary the paper was extremely significant in the history of the South African Iridaceae. Prior to the publication of de la Roche's study, only 22 species had been described, mostly by Linnaeus and usually only very briefly. The addition of 20 more species to the list was surely important. In view of this it is in fact surprising that no serious study of de la Roche's work has been made.

The thesis, published in book form, was widely distributed and de la Roche's specific epithets were in most cases taken into the literature. Although the

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Accepted for publication 14th July, 1970.

SPECIMEN BOTANICUM  
INAUGURALE,  
SISTENS  
DESCRIPTIONES PLANTARUM  
ALIQUOT NOVARUM.

QUAM,  
ANNUENTE SUMMO NUMINE,  
*Ex Auctoritate MAGNIFICI RECTORIS,*  
FRIDERICI BERNARDI ALBINI,

A. L. M. PHIL. ET MED. DOCTORIS, ANATOMES ET CHIRURGIE  
IN ACAD. LUGD. BAT. PROFESSORIS ORDINARIJ,

NEC NON

*Amplissimi SENATUS ACADEMICI Consensu, &  
Nobilissime FACULTATIS MEDICÆ Decreto,*

PRO GRADU DOCTORATUS,

Summisque in MEDICINA Honoribus & Privilegiis,  
ritè ac legitime consequendis,

*Eruditorum Examini Submittit*

DANIEL DE LA ROCHE,  
GENEVENSIS.

*Ad diem 29. Aug. MDCCCLXVI. H. L. Q. S.*



LUGDUNI BATAVORUM,  
Apud JOH. ET HERM. VERBEEK, 1766.

FIG. 1.

Frontispiece of de la Roche's doctoral thesis.

descriptions were fairly detailed and very good for that early day, the identity of the majority of his species has always remained doubtful because no type specimens could be located. Fortunately the thesis contained five coloured illustrations which have since been selected as types for the species concerned. These are *Ixia paniculata*, *Gladiolus permeabilis*, *G. involutus*, *G. carneus* and *Vieusseuxia spiralis*. The illustrations are fairly good and the species concerned can readily be identified with living plants except for *G. carneus* which has caused a little difficulty.

Although the identity of the remainder of the species was rather doubtful, several authors attempted to place them correctly, and as the present authors will show, often with remarkable accuracy. For example Ker referred the first four of de la Roche's *Ixias* to *Geissorhiza* and two of these were assigned to the correct species. Ker also referred *Ixia fabricii* to *Lapeirousia*, and *Ixia thyrsiflora* to *Aristea*. Many of the early botanists did not recognise the priority rule so that although de la Roche's names are the earliest for the species they were regarded as synonyms.

The present study is an attempt to identify de la Roche's plants correctly, and to correct some of the taxonomic errors which exist with regard to them.

#### THE SEARCH FOR TYPE MATERIAL

##### 1. *The nature of de la Roche's specimens*

De la Roche mentioned that most of his descriptions were made from dried specimens including his first 12 *Ixias*. He listed the source of few of his specimens. *Ixia fabricii* was described as having been received from F. W. P. Fabricius, a contemporary naturalist, and he stated that Van Royen provided a specimen of *Vieusseuxia aristata*. Some of de la Roche's plants were described from living specimens, among them the species of *Gladiolus*, *Ixia crocata*, *I. paniculata*, *Vieusseuxia spiralis* and *V. fugax*. With the exception of the two *Ixias*, these plants were flowered in the gardens of Van Hazen, a commercial flower grower at Leiden. *V. fugax* was illustrated in a Catalogue of Plants issued by Van Hazen and as de la Roche quotes this illustration it serves not only to identify the species but is the type.

##### 2. *Linnaeus' annotated copy of the thesis*

In the Linnaean Library (London) there is a copy of the thesis which was annotated by Van Royen who sent it to Linnaeus in February 1767. The notes added by Van Royen are in many instances very useful in helping to identify de la Roche's plants. It appears that Van Royen had specimens of several of the species which de la Roche described from dried material. The collection is far from complete and even those that Van Royen did have do not appear to

be types, for the phrase "I have a dried specimen" is often qualified, "but not branched" (for *Ixia imbricata*), or "but less complete" (for *I. secunda*).

Van Royen mentions which species were described from living plants and also states when he has illustrations of the plants. He noted that he had a traced copy of the specimen of *Ixia fabricii*, a problem species, but unfortunately this can no longer be found.

The marginal notes also reveal the location of the types of *Ixia* species 8, 9 and 10, namely *I. monanthos*, *I. latifolia* and *I. monadelpha*. These species were not known to Van Royen, who states that de la Roche had specimens from Burman's collection. Although it is not known whether the specimens today in the Burman collection are the same or whether de la Roche had duplicates, the former seems likely, for Burman usually had specimens sent from his collection returned to him. The specimens match the descriptions in every respect and it seems reasonable to assume these are holotypes.

### 3. The Burman and de Candolle collections

Specimens of de la Roche's species were borrowed from the Burman Herbarium and the de Candolle Herbarium both located at Geneva, de la Roche's native city. The Burman specimens were borrowed because de la Roche is known to have been in communication with Burman fil., and as indicated in the text of his thesis, saw and received specimens from Burman's collection. In addition the types of *Ixias* 8, 9 and 10 were believed to be in this collection.

For some time many of de la Roche's types were believed to be amongst Burman's collection. This idea seems to have originated with N. E. Brown (1929) but the reason for this assumption is not clear and cannot be accepted for any of the species other than the three *Ixias* mentioned by name in Linnaeus' annotated copy of the thesis.

De Candolle specimens were borrowed to check the statement in de Candolle's *La Phytographie* that Daniel de la Roche's specimens were situated in the de Candolle Herbarium. The types of the 20 species under discussion do not appear to be in this collection and judging from the material sent on loan all the specimens are of a later date. As this collection proved of no use it will not be discussed further.

The Burman collection proved useful but as was expected, contained no evidence that any of the specimens were the types or had even been seen by de la Roche. Indeed it appears that Burman knew most of de la Roche's plants only from the written descriptions, for many are obviously incorrectly identified and sometimes species in different genera bear the same de la Roche specific epithet. Specimens of the species of *Ixia* described from Burman's collection were present and constitute the most significant of those loaned from Geneva.

#### 4. The Van Royen collection

The discovery which initiated the present study was the information that specimens of *Gladiolus involutus* and *G. permeabilis* (both of de la Roche) which were loaned to the S.A. National Herbarium from the Rijksherbarium at Leiden, contained manuscript drafts of the descriptions of these two species which de la Roche published. Two foolscap sheets were found in the folders with each species, one a rough draft and the other a fair copy, endorsed "made by me for the use of D (ominus) de la Roche" and dated 15th and 17th August 1766 respectively for *G. involutus* and *G. permeabilis*.

This news led the present authors to request from Leiden the loan of all the specimens of the species described by de la Roche that were in Van Royen's collection. It was hoped that this collection would contain if not type material, at least correctly identified specimens as Van Royen must have known exactly what de la Roche's species were.

The material from Leiden proved to be extremely interesting. There appear to be specimens of only 14 of de la Roche's species in the Van Royen collection (including the two *Gladiolus* species mentioned). Amongst these are several more manuscripts in Van Royen's hand, containing descriptions of *Ixia iridifolia*, *I. paniculata*, *Vieusseuxia spiralis*, *V. fugax* and *V. aristata*. In addition there is a draft on the description of *V. aristata* in another hand, presumed to be that of de la Roche himself.

This raises the question about how much of the description was in fact written by de la Roche. Probably Van Royen merely corrected and rewrote de la Roche's descriptions. There is some evidence for this, as Van Royen wrote at the top of the rough draft for *G. permeabilis* the note that, "the leaves cannot be *linearibus*", but subquadrangular, *linearibus* implies that the leaves are flat". Is this the tutor correcting his student?

There is no indication that any of the specimens are type material but an examination of the specimens reveals that, with the possible exception of *V. aristata*, all specimens are the same species as described by de la Roche. Some may even be type specimens but there seems to be no way of proving this especially as the descriptions are not so detailed as to reveal the exact number of flowers or branches or leaves, or the exact length of these structures.

#### THE IDENTIFICATION OF SPECIES

Following the information obtained from the study of herbarium specimens and Linnaeus' copy of the thesis, a detailed examination of de la Roche's descriptions was made. As a result, almost all the 20 species could be identified with confidence. The results of the study will be discussed for each species following the sequence of de la Roche.

## IXIA

1. *I. inflexa*

At present this is known as *Hesperantha inflexa* (de la Roche) Foster. It was transferred to *Hesperantha* by Foster (1941) who noticed the similarity of the colouring of the flowers of *Hesperantha metelerkampiae* L. Bol to de la Roche's description. Other features which were perhaps more critical were ignored. De la Roche described the plant as having a filiform style. This is not a feature of *Hesperantha*, which has a short style that branches at the throat of the perianth tube, a character which de la Roche would have recorded if it had been present.

Other features mentioned were the leaves bearing scattered hairs and the outer floral bract described as dry and withered, and almost as long as the corolla. *Hesperantha metelerkampiae* is quite clearly glabrous and although the outer bract is dry it is not as long as described and rarely reaches more than half the length of the corolla.

The plant named *Ixia inflexa* from Leiden matches de la Roche's description very closely. It is a species of *Geissorhiza*, typical in having a filiform style, divided at the apex into three short branches. It is villous, and has dry bracts reaching to the top of the flowers. It is also, as described, inflexed or bent at the base of the spike, making the flowers secund. This specimen matches very closely the plant at present known as *Geissorhiza quinquangularis* Ecklon ex Klatt.

The history of *Ixia inflexa* is illuminating. It was cited as a synonym of *Ixia hirta* Thunb. (1784). Later when Ker (1805) created the new genus *Geissorhiza* he recognised both *G. hirta* and *G. inflexa* which was based on de la Roche's species. *G. hirta* is a dark blue flowered form of de la Roche's plant. The name is illegitimate as it was superfluous when published but the species is regarded as the same as what is now known as *G. erosa*. Later authors also considered *Ixia inflexa* as a *Geissorhiza* and Baker (in Thistleton-Dyer 1896) recognised it as a distinct species although he knew it only from the description and cited *G. vaginata* Sweet (actually a *Hesperantha*) as a synonym.

The present authors regard *Geissorhiza erosa* as a variety of *G. quinquangularis* (i.e. *G. inflexa*) for it differs only in flower colour and general size and the distribution of the two overlaps considerably. The variety *G. erosa* var *kermesiana* (Klatt) Foster, regarded as being a smaller plant with fewer flowers is variable and the present authors have observed specimens from the same population that are large with many flowers. The variety is thus not really separable from *G. erosa*. The variety *G. quinquangularis* var *atrofaux* is merely a colour form of the species and should be reduced to synonymy.

De la Roche's plant is now believed to be correctly understood and must be



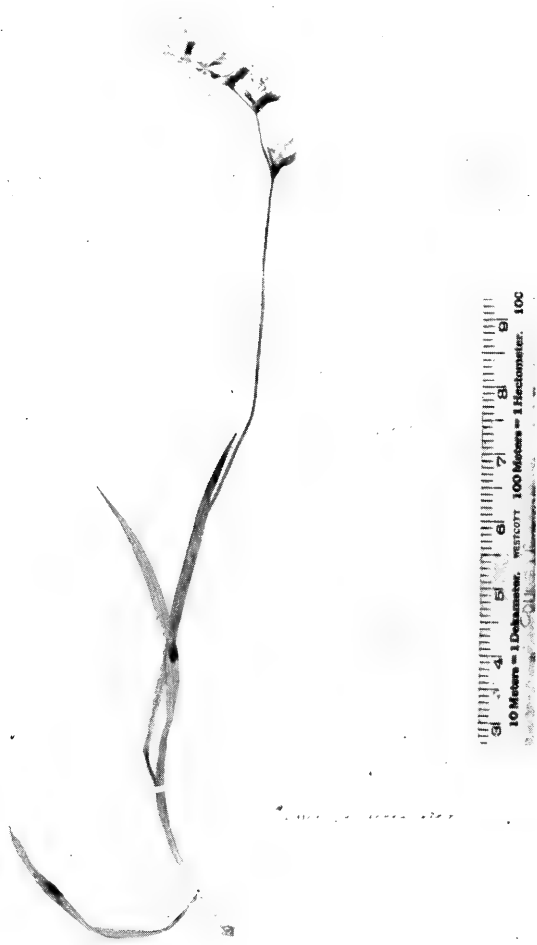


FIG. 2.

The specimen labelled *Ixia inflexa* from Van Royen's collection at Leiden, which gave a clue as to the true identity of this species.

known as *Geissorhiza inflexa*. As the type specimen is not known a neotype is proposed for this species. The specimen which has been chosen is *Barker* 3869 from Lion's Head, Cape Pen. (BOL, NBG), which is one which matches the description closely. The following changes must be made.

***Geissorhiza inflexa*** (de la Roche) Ker in K. & S. Ann. Bot. **1**: 224 (1805). *Ixia inflexa* de la Roche, Descr. Pl.; 15 (1766) Neotype: *Barker* 3869 (BOL, NBG)!

*Hesperantha quinquangularis* Eckl., Top. Verz.: 23 (1827) nom nud.

*Geissorhiza quinquangularis* Eckl. ex Klatt in Linnaea **34**: 654 (1866) Holotype: *Ecklon & Zeyher* 214 (B) Isotype SAM!

*Hesperantha quinquangularis* (Eckl. ex Klatt) Klatt in Durand & Schinz, Conspec. Fl. Afr. **5**: 176 (1893).

*Geissorhiza hirta* var *quinquangularis* Bak., Handbk. Irid: 156 (1892). Lectotype: *Ecklon* 312 (K).

*Geissorhiza quinquangularis* var *atrofaux* Foster in Contr. Gray Herb **135**: 55 (1941) Holotype: *Schlechter* 5210 (B) Isotype SAM!

*Geissorhiza graminifolia* var *bicolor* Bak., Handbk. Irid: 155 (1892) Lectotype: *MacOwan* 261 (K) (isotypes BOL. SAM!).

***Geissorhiza inflexa*** var *erosa* (Salisb.) Goldblatt stat. nov. et comb. nov.

*Ixia erosa* Salisb., Prodr. 36 (1796), basionym. Type: unknown. Neotype: *Leighton* 1338 (BOL!).

*Geissorhiza erosa* (Salisb.) Foster in Contr. Gray Herb. **135**: 52 (1941).

*Hesperantha kermesiana* Klatt, Erganz.: 61 (1882) Holotype: *Drege* 8480 (excl. plant marked a) (B).

*Geissorhiza erosa* var *kermesiana* (Klatt) Foster in Contr. Gray Herb. **135**: 53 (1941).

*Ixia hirta* Thunb. Diss. Ixia 6 (1784) nom. illeg. Holotype: Herb. Thunb. 958 (UPS) microfiche!

*Geissorhiza hirta* (Thunb.) Ker in K. & S. Ann. Bot. **1**: 224 (1805).

The species of *Hesperantha* to which Foster mistakenly applied the name *H. inflexa* must now be known by an earlier epithet based on *Geissorhiza vaginata*. The present authors have noted that a variety of the present *H. inflexa* i.e. var *stanfordiae* has no taxonomic value as it is only a concolorous form of the species. In some localities both colour varieties occur together (*Goldblatt* 352 BOL). This opportunity is taken to reduce this variety as well as to correct the nomenclature of this species.

***Hesperantha vaginata*** (Sweet) Goldblatt comb. nov.

*Geissorhiza vaginata* Sweet in Brit. Fl. Gard. **2**: t.138 (1826), basionym. Holotype: illustration as cited in Brit. Fl. Gard.



IN HEAD, 1000, NAT.  
• HER. BOGOTÁ.

GLADIOLUS QUADRANGULA HER-BOWL.

*Gladiolus quadrangula*

*Ixia quadrangula*

*Gladiolus quadrangula* (L.f.) N. E. Brown

900440

FIG. 3.

The specimen labelled *Ixia quadrangula* from Van Royen's collection. The specimen is identical to *Gladiolus linearis* (L.f.) N. E. Brown.

*Hesperantha metelerkampiae* L. Bol. in Ann. Bot. Herb. **4**: 114 (1927)  
Holotype: *Metelerkamp s.n.* (BOL 18555)!

*Hesperanthe stanfordiae* L. Bol. in S.A. Gard. **21**: 282 (1931) Holotype  
*Buhr. s.n.* (BOL 19880)!

*Hesperantha inflexa* var *stanfordiae* (L. Bol.) Foster in Contr. Gray Herb.  
**166**: 17 (1948).

*Hesperantha inflexa* sensu Foster (non de la Roche) in Contr. Gray Herb.  
**135**: 77 (1941).

## 2. *Ixia quadrangula*

The identity of this plant has for many years been unknown. It has been referred to *Geissorhiza* but never matched with any living or known species of this genus. It was tentatively placed in *Geissorhiza* by Ker (1827) who regarded it as an imperfectly known species. It was treated as a *Geissorhiza* in Flora Capensis but has remained a species known only from the description.

There is a specimen bearing this name in Van Royen's collection and this proved on examination to be a species of *Gladiolus*. A study of the description reveals that this specimen matches closely all the characters mentioned by de la Roche. This plant is the same species as *Ixia linearis* Lf. (1781) and *Gladiolus biflorus* Klatt (1885). De la Roche's name is earlier than these and thus has priority. This species should now be known as *Gladiolus quadrangulus* as there is no bar to the use of this epithet in the genus *Gladiolus*. There is a similar name in the literature, *G. quadrangularis*, a later synonym for the plant now known as *Petamenes abbreviatus* (Andr.) N. E. Brown. As there is little likelihood of the similarity of these names causing confusion, it is admissible according to the rules of nomenclature.

The confusion over *Ixia quadrangula* is easy to understand. It is one of the few actinomorphic species of *Gladiolus* (Lewis 1954) and in this respect resembles *Geissorhiza*. The actinomorphic species of *Gladiolus* were regarded by Lewis as intermediate between this genus and *Geissorhiza* and are only recognised as belonging to the former by the possession of winged seeds.

The taxonomic treatment is as follows:

***Gladiolus quadrangulus*** (de la Roche) Barnard comb. nov.

*Ixia quadrangula* de la Roche Descr.: 16 (1766), basionym. Neotype: Goldblatt 525 (BOL).

*Geissorhiza quadrangula* (de la Roche) Ker. Genera Iridacearum: 88 (1827).

*Ixia linearis* Lf. Suppl.: 92 (1781) Type: Herb. Thunb. 958 (UPS)!

*Gladiolus linearis* (Lf.) N. E. Br., in J. Linn. Soc. Bot. **48**: 48 (1928).

*Gladiolus biflorus* Klatt in Trans. S.A. Phil. Soc. **3**: 198 (1885). Holotype: MacOwan 2279 (SAM)!

### 3. *Ixia imbricata*

This species was apparently quite well understood in spite of the absence of any type specimens. Ker (1805) transferred this species to *Geissorhiza* when he first described this genus, and it has since remained in this position. There is a specimen referred to this species in the Burman collection and it appears to be correctly identified, but there is no specimen in the Van Royen collection.

As there seems to be no difficulty in identifying de la Roche's species with the Burman specimen this can be taken as the standard but it is not the type for it lacks the branches mentioned in the description. The authors propose *Salter 7034* (BOL) from Lakeside, Cape Peninsula as the neotype. This specimen has slender branches and is the same height as the plant described by de la Roche. This species remains:

***Geissorhiza imbricata*** (de la Roche) Ker in K. & S. Ann. Bot. **1**: 224 (1805).

### 4. *Ixia secunda*

This is another species of *Geissorhiza*. It was transferred here by Ker (1805) who placed *Ixia secunda* Bergius (1767) in the same genus. These are two different species as Ker realised. Instead of recognising the priority of de la Roche's epithet, he called Bergius' plant *Geissorhiza secunda*, and de la Roche's plant *Geissorhiza rochensis*. He had, prior to this, renamed de la Roche's *Ixia rochensis* (Ker 1803a). The plant which Ker described and figured was however, not the same species as de la Roche's *Ixia secunda*. Though both are similarly coloured, de la Roche's plant is larger and has broad leaves which in Ker's plant are subterete.

Both *Ixia secunda* of de la Roche and of Bergius were cited in the synonymy of *G. secunda* by Baker in *Flora Capensis*, and the true identity of de la Roche's plant remained confused. In his revision of *Geissorhiza*, Foster (1941) discusses this problem and is able to match a known plant, *Geissorhiza mathewsii* var *eurystigma* (L. Bol.) Foster with de la Roche's plant. Although the present authors doubt the validity of the variety as it differs very little from the species, Foster's determination is upheld. De la Roche's description mentions the peculiar broad stigmas that are also found in *G. mathewsii*, and the colouring of the flower is the same.

This identification is further supported by a specimen from Van Royen's Herbarium. There is a single specimen named *Ixia secunda* de la Roche and this plant matches exactly collections of *Geissorhiza mathewsii* var *eurystigma*.

Taxonomically the problem of the correct names of the two plants is complex. Bergius' plant is at present known as *G. secunda* (Berg.) Ker but this citation seems to be invalid. This is because *Ixia secunda* is illegitimate if applied to any but de la Roche's plant. The reason for this is that Bergius cited *Ixia*



*secunda* de la Roche in the same work in which he published his *I. secunda*. Apparently Bergius had by coincidence also chosen the epithet *secunda* and when he received a copy of de la Roche's thesis, several months before his own work was published, he added an appendix at the end of his book citing *Ixia secunda* de la Roche as a synonym. This implies that he thought the two were the same, and according to present day rules of nomenclature he invalidated his species. In spite of this, Ker chose to transfer *Ixia secunda* Berg. to *Geissorhiza* as *G. secunda*, and, as he knew de la Roche's plant was a different species, he renamed it.

Foster (1941) was aware of this rather unsatisfactory state but he upheld *G. secunda* (Berg.) Ker. Foster's grounds for doing so were that it was an old and well known specific name which he thought proper to retain in spite of it being based on a later homonym. This decision does not unfortunately seem admissible as it is taxonomically incorrect. As there is no available synonym for the plant at present called *Geissorhiza secunda*, a new name *G. aspera* is proposed.

***Geissorhiza aspera*** Goldblatt sp. nov. Holotype: *Goldblatt 501* (BOL).

*Gladiolus junceus* Burm. f., Prod. Fl. Cap.: 2 (1768) nom. nud.

*Ixia secunda* Berg. (non de la Roche), Pl. Cap. 6 (1767).

*Geissorhiza secunda* sensu Ker (non de la Roche) in K. & S. Ann. Bot. 1: 224 (1805).

*Caudex* cormus ovato- conicus, tectus squamis plurimis imbricatis lignosis, infra fisis. Folia 4—5, inferiora vaginata, superiora 3 laminata, lineata, glabra, raro longiora caule, media costa solum prominens. *Caulis* usitatis paucos ramos ferens, gracilis, flexuosus, asper. *Inflorescentia* laxa, 2—7 flores, inflexa. *Bractee* 2, obovatae, herbaceae sed brunnes-membranaceae supra, interiora breviora exteriore. *Corolla* sexpartita, perianthii tubus brevis, segmenta subaequalis,  $\pm 1$  cm longa,  $\pm 4$  mm lata, obovata subacuta, hyacinthina. *Stamina* 3, aequilaterialis, *Stylus* longus antheris, stigmata 3, recurva. *Fructificatio* capsula, semina globosa, angulata.

*Geissorhiza secunda* (Berg.) Ker apparently serves to bar the transfer of de la Roche's *Ixia secunda* to *Geissorhiza* and this plant accordingly remains *Geissorhiza mathewsii* var *eurystigma* (L. Bol.) Foster.

##### 5. *Ixia fabricii*

This plant has long been recognised as a species of *Lapeirousia*, a genus created by Pourret (1788), but there is unfortunately no specimen of *I. fabricii* in either Burman's or Van Royen's collection to help with the identification of this plant. The description is however, fairly detailed and although the distinctive bifid stigmas of *Lapeirousia* were not observed by de la Roche, it can

readily be identified as *L. anceps* (L.f.) Ker. This is conspecific with *L. compressa* on which the genus was based.

De la Roche's description unmistakably applies to this species which is the only one with flattened stems, denticulate leaves, many branches and lilac flowers with a long perianth tube. The only difficulty which can be raised is the fact that the perianth tube is described as four times the length of the segments. Most specimens of this species have a shorter tube, approximately two and a half times the length of the segments. An examination of herbarium specimens reveals that the shorter tube is the norm, but a longer perianth as described by de la Roche does occur in some specimens.

There has in the past been considerable confusion about the identity of *L. fabricii* and at present the name is incorrectly applied to a second species. The identity and correct names of the two species is confused and both will have to be dealt with here. The confusion begins with the correct identity of *Lapeirousia anceps*. This was first described by Linnaeus fil. as *Gladiolus anceps*. In his description, Thunberg is cited as the source of the plant. There is a Thunberg specimen bearing this name in Herb. Linn. which is the same species as the specimen so named in Herb. Thunb. There are, however, two other specimens in Herb. Linn. also labelled *G. anceps* but are in fact another species. One of these, bearing the inscription, "Sp. 192" (presumably having been collected by Sparrman) bears the epithet "*decurrens*" in Linnaeus' hand.

*Ixia decurrens* is a Linnaean manuscript name appearing in the manuscript *Supplementum Plantarum* which was later published by Linnaeus fil. after his father's death. The description of *I. decurrens* is almost the same as the published description of *G. anceps* but in the manuscript, the plant is attributed to Sparrman. In the amanuensis draft of the *Supplementum*, the younger Linnaeus has deleted *Ixia decurrens* and substituted *Gladiolus anceps*. The amanuensis draft description has been altered very slightly by the younger Linnaeus so that the description remains essentially that of Linnaeus. In the published form the description still applies to the plant originally intended by Linnaeus and not to the Thunberg specimen.

The only important change made by the younger Linnaeus is the alteration of the word "*angulatus*" to "*anceps*" in the description of the stem. This latter term, meaning flattened applied better to the Thunberg specimen. Linnaeus fil., however, left the description of the corolla tube as being three to four times the length of the petals. This can only apply to the Sparrman plant, for in the Thunberg specimen the perianth tube is less than three times the length of the petals.

Thus *Ixia decurrens* was described by Linnaeus from a Sparrman specimen but in the published form of the description, altered slightly by Linnaeus fil., the name *Gladiolus anceps* is substituted, and the specimen attributed to Thun-



berg. As typified by the Sparrman specimen, the only one to which the description can apply, *G. anceps* should be recognised as the plant at present called *L. fabricii* and not what is presently known as *G. anceps* which is based on Thunberg's specimen.

The issue was further clouded by Thunberg, who in 1784 described *G. anceps* this time clearly referring to his own specimen, although he does cite Linnaeus fil. Subsequently in 1800 Thunberg described *G. fabricii*, the same species as Linnaeus' *Ixia decurrens*. Thunberg cites *Ixia fabricii* de la Roche in the description which is thus regarded as the basionym. Thus *Gladiolus fabricii* Thunb. is typified not by the specimen so labelled in Thunberg's Herbarium but by de la Roche's species which he erroneously believed to be the same. Thunberg created more confusion in his *Flora Capensis* (1823) by citing *Ixia fabricii* de la Roche as a synonym of both *G. anceps* and *G. fabricii*.

The species today regarded as *Lapeirousia fabricii* is the same as Thunberg's specimen of *Gladiolus fabricii* but as this specimen is incorrectly identified, the name *L. fabricii* must apply to de la Roche's species, which is at present known as *L. anceps*. The correct identity of *L. anceps*, based on Linnaeus fil's *Gladiolus anceps* is Thunberg's *Gladiolus fabricii*, at present called *L. fabricii*. Thus the names of these two species must be transposed.

The taxonomic treatment and synonymy of the two species is as follows:

***Lapeirousia fabricii*** (de la Roche) Ker in Bot. Mag. t.1246 (1810).

*Ixia fabricii* de la Roche, Descr. 5 (1766) non sensu Thunb. (1800) Neotype: *Leipoldt s.n.* (BOL 17111)!

*Gladiolus denticulatus* Lam., Encyc. 2: 728 (1786) Type: Herb. Lamarck (P).

*Lapeirousia denticulatus* (Lam.) Lawrence in Baileya 3: 134 (1955).

*Lapeirousia compressa* Pourret in Mem. Ac. Sci. Toul. 3: 79–82 (1788) Holotype: in Mem. Ac. Sci. Toul. t.6 (1788).

*Lapeirousia aculeata* Sweet, Hort. Brit. ed. 1: 396 (1827) nom. nud.

*Peyrouisia aculeata* Sweet in Brit. Fl. Gard. ser. 2 t. 39 (1830) Holotype: in Brit. Fl. Gard. ser. 2 t. 29.

*Meristostigma aculeata* (Sweet) A. Dietr., Sp. Pl. 2: 593 (1833).

*Ovieda aculeata* (Sweet) Klatt in Linnaea 32: 777 (1863).

*Lapeirousia serrulata* Schltr. in Journ. Bot. 3: 432 (1897) Holotype: *Schflechter 9099* (B) Isotypes BOL, K, SAM!

"*Gladiolus anceps*" sensu Thunb. (non L.f.) Diss. Gladiolo 17 (1784).

"*Lapeirousia anceps*" sensu Ker in K. & S. Ann. Bot. 1: 238 (1805).

"*Ovieda anceps*" sensu Sprengel, Syst. Veg. 1: 147 (1825).

"*Peyrouisia anceps*" sensu Poir, Dict. Sc.

"*Meristostigma anceps*" sensu A. Dietr., Sp. Pl. 2: 593 (1833).

***Lapeirousia anceps*** (L.f.) Ker in K. & S. Ann. Bot. 1: 238 (1805).

*Gladiolus anceps* L.f. Suppl.: 94 (1781). Holotype: *Sparrman 192* Linn. Herb. 59/20 (microfiche).

*Lapeirousia pentheri* Bak. in Kew Bull: 27 (1906). Type: *Penther 728* (BOL); Isotypes (BM, KEW)!

"*Gladiolus fabricii*" sensu Thunb., Prod. Pl. Cap.: 186 (1800) non de la Roche (1766).

"*Lapeirousia fabricii*" sensu Ker in Bot. Mag. Sub t. 1246 (1809).

"*Ovieda fabricii*" sensu Sprengel, Syst. 1: 147 (1825).

"*Peyrousia fabricii*" sensu Sweet, Hort. Brit. ed. 2: 499 (1830).

"*Meristostigma fabricii*" sensu A. Dietr., Sp. Pl. 2: 593 (1833).

#### 6. *Ixia bulbocodioides*

According to de Vos (private communication) the plant at present known as *Romulea bulbocodioides* (de la Roche) Ecklon is not the species that de la Roche described as *Ixia bulbocodioides*. The original description is quite detailed and there is no doubt that de la Roche did have a species of *Romulea*, but he described the corm as having a hard woody covering and campanulate with a circular base. The corm of the plant presently, but erroneously known as *R. bulbocodioides*, is asymmetric, having an obliquely flattened base with a crescent-shaped ridge; the correct name for this species is *R. flava* based on *Ixia flava* Lamarck.

De Vos regards the identity of de la Roche's plant as doubtful, for although it resembles *R. triflora* (Burm. f.) N. E. Brown, the description of the leaf does not quite correspond with this species. Unfortunately, no type or authentic specimen for *Ixia bulbocodioides* can be found. Van Royen states in the annotated copy of the thesis that he did have a specimen of this plant, but this specimen can no longer be found in his collection.

Until *Ixia bulbocodioides* can be more confidently identified the name should perhaps be discarded, and what is today called *R. bulbocodioides* should be re-named with the next available epithet:

***Romulea flava*** (Lam.) de Vos; nov. basionym, *Ixia flava* Lamarck, Encyc. III, 1: 109 (1791). Holotype: Herb. Lamarck (P).

#### 7. *Ixia thyrsiflora*

In his study of Burman's herbarium, Brown (1929) stated that the specimen named *I. thyrsiflora* was the same as de la Roche's plant, and on this basis he transferred this de la Roche species to *Aristea* as synonymous with *A. major* Andr. (1801) and *A. capitata* (L.) Ker. In his revision of *Aristea* (Weimark 1940) accepts this combination and regards the Burman specimen at Geneva as the type of de la Roche's plant.

An examination of de la Roche's description and the foot-note he adds to it reveals that the above is incorrect. De la Roche describes a plant with an inflorescence of about a foot or more in length, with a flexuose axis, which has short branches closely applied to the stem. The footnote explains that a plant which he received from Burman is not the same. The description of this specimen reveals that this is unbranched with the flowers in a simple spike. A joint below the spike from which a small leaf is produced is also mentioned. De la Roche concludes that although Burman's plant differs in many respects it is similar enough to be regarded as the same species. As de la Roche was dealing mostly with *Ixia*-like plants, the similarity of two *Aristeas* would naturally have lead him to this conclusion. There is, however, little doubt that the so called type of *Ixia thyrsiflora* in Burman's collection is this latter plant mentioned in the footnote, which differed somewhat from the species de la Roche actually described.

As *Aristea* is far better known today it is clear that de la Roche's plant, though similar to Burman's, belonged to a different species. From the description *Ixia thyrsiflora* is very difficult to recognise because *Aristea* species are distinguished on fruit and seed characteristics, not noted in detail by de la Roche. In the absence of a type specimen it is therefore necessary to discard this name.

The plant at present referred to *A. thyrsiflora* should then be known by a later epithet. Brown mentioned two, *A. major* Andrews and *A. capitata* Ker. The latter name is really a Linnaean epithet, Ker (1803b) having transferred *Gladiolus capitatus* L. (1753) to *Aristea*. Today *A. capitata* (incorrectly attributed to Ker alone) is applied to a different species from the one Ker actually illustrated which is the same as Andrew's *A. major* and Burman's *A. thyrsiflora*. Presumably then *A. capitata* sensu Weimarck, but not as illustrated by Ker, is assumed to be the same as Linnaeus' *Gladiolus capitatus*. The latter plant cannot be typified so its identity can only be determined from the description. This is extremely brief and refers to a very large, blue flowered plant with a capitate inflorescence. While this is clearly most likely to be an *Aristea*, the present authors agree that it is not possible to identify the plant with any one of the larger *Aristea* species. Consequently this name should also be discarded.

*Aristea major* Andr. is thus the earliest valid synonym for *A. thyrsiflora* sensu Burman (non de la Roche). *Aristea capitata* sensu Weimarck and Ker (non Linnaeus) is now without a name and *A. confusa* is proposed.

***Aristea major*** Andrews in Bot. Rep. t. 160 (1801) Holotype: illustration cited in Bot. Rep.

*Aristea spicata* Persoon, Syn. Pl. 1: 41 (1805) nom. illeg. (type as for *A. major* Andr.).

"*Aristea thyrsiflora*" sensu Brown (non de la Roche) in Kew Bull **1929**: 36; sensu Weimarck in Lunds Univ. Arssk. **36**: 86 (1940)

"*Aristea capitata*" sensu Ker (non Linn) in Bot. Mag. t. 605 (1803).

***Aristea confusa*** Goldblatt sp. nov. Holotype: *Stokoe s.n.* (BOL 17518).

"*Aristea capitata*" sensu Weimarck (non Ker nec Linn.) in Lunds Univ. Arssk. **36**: 86 (1940).

*Planta* robusta ad 1m alta. *Caudex* rhizomata erecta; folia 3—6 rigida ad 40 cm. *Inflorescentia* 20—35 cm longa, paniculata ramis brevibus, ad axis flexus. *Bractee* ovata acuta vel acuminata, scariosa, brunnea. *Corolla* pedicellata, perianthii segmenta ad 20 mm longa, et 8 mm lata, obovata cuneata. *Staminum* filamenta 7—8 mm longa, antherae oblongae 3 mm longae. *Stylus* 8—9 mm longus, stigmata subglobosa. *Capsula* ad 15 mm longa, 8 mm lata, triolata; semina in eodem loculo 2—3 vel raro ad 4, lamelliformia ad 5 mm longa irregulariter ovatoangulato, marginibus papillis brevibus densis munita.

#### 8. *Ixia latifolia*

According to Linnaeus' annotated copy of the thesis this is one of the species described by de la Roche from a Burman specimen and there is no problem about its identification. Both the specimen in van Royen's and the one in Burman's collection are of the same species and match the description. In her revision of *Ixia*, Lewis (1962) regards the Burman specimen as the holotype, a decision which the present authors accept. The species remains

***Ixia latifolia*** de la Roche

#### 9. *Ixia monanthos*

*Ixia monanthos* was also described from a specimen sent to de la Roche by Burman. Van Royen's collection contains no specimen of this species and there is only a single specimen in Burman's collection. This specimen is remarkably like the plant described and should be regarded as the holotype. N. E. Brown (1929) believed that the inscription on this specimen which reads "*Ixia monanthos floruit 1759*," was in de la Roche's hand. This is very unlikely as de la Roche was at that date only sixteen years old. An examination of the script reveals that it is very similar to that of Burman senior, a more likely answer. If this is so, then strictly speaking the species should be cited as Burman ex de la Roche.

This plant has caused some difficulty in identification but it is closest to *Sparaxis grandiflora* subsp. *acutiloba* Goldblatt. The difference is that *Ixia monanthos* has large dark markings in the centre of the perianth segments, a character not observed in any specimens of this subspecies of *Sparaxis grandi-*

*flora*. This has led to the suggestion (Goldblatt 1969) that it is perhaps a hybrid. At the rank of subspecies the name *monanthos* does not have priority so that even if it can be determined with certainty, no name change will be necessary.

#### 10. *Ixia monadelpha*

This is the last of the three species described from Burman's specimens. The Burman collection contains two specimens of this species, one a Houttyn specimen acquired later than 1766 by Burman. The other is probably de la Roche's specimen. In her revision of *Ixia*, Lewis (1962) accepted this specimen as the holotype and this decision must be supported.

There are several sheets of this species in Van Royen's collection, all bearing the correct name, and these serve to confirm the identity of de la Roche's plant which remains known as

***Ixia monadelpha* de la Roche**

#### 11. *Ixia grandiflora*

From the description of its bracts and flower this species can easily be identified as a *Sparaxis* and is the plant now recognised as *S. grandiflora* (de la Roche) Ker subsp. *grandiflora*. In a revision of *Sparaxis* (Goldblatt 1969), a neotype was selected for this species. The specimens of this plant in Burman's Herbarium were rejected as possible types, for there was and still is no reason to suppose that de la Roche described this species from Burman's material.

There are also several specimens of this species in Van Royen's collection. De la Roche probably saw those that were contemporary but the exact age of the specimens is not known. The presence of specimens of this species in Van Royen's collection named *Ixia grandiflora* de la Roche, confirms its identity, but there is no reason to suppose that any of the specimens are type specimens either. Thus the neotype which has been selected remains the type of this species, now called

***Sparaxis grandiflora* (de la Roche) Ker subsp. *grandiflora***

#### 12. *Ixia flabellifolia* de la Roche

There was for a long time considerable doubt about the identity of this species. It appears to have been disregarded until N. E. Brown (1929) found specimens bearing this name in Burman's Herbarium. Of the four specimens he found, two were species of *Babiana*, one an *Engysiphon* and the last Brown identified as de la Roche's species. This was the same as the plant known then as *Acidanthera capensis* and Brown made the new combination *Acidanthera flabellifolia* as this epithet was the oldest for the species. This species was

transferred to *Tritonia* by Lewis (1941) who presumably accepted the Burman specimen as the type though she does not indicate this.

There are several specimens of this species in Van Royen's collection all labelled *Ixia flabellifolia*. Neither these nor the Burman specimen have any claim to be type material. There is one specimen in Van Royen's collection which conforms closely to the description in size, length of perianth tube and number of branches. It is mounted on the top left of a sheet with two others but these do not appear to belong to the same collection. It is proposed that this specimen be selected a neotype for

***Tritonia flabellifolia* (de la Roche) Lewis**

### 13. *Ixia iridifolia*

There seems to be no doubt of the identity of this species as de la Roche cites Miller's *Icones*: 160, t. 239 f.2. This is an illustration of the plant known today as *Tritonia crocata* (L.) Ker.

De la Roche mentioned that he saw live specimens of Miller's plant, and he probably also had dried specimens. It is therefore unlikely that Miller's illustration is also the type of de la Roche's plant. There are many specimens of this species in both the Burman and Van Royen collection. None of those in the former collection is labelled "*iridifolia*" but bear the earlier Linnaean epithet "*crocata*" and are in fact a mixed collection of several species. In the Van Royen collection all the plants are *T. crocata* and bear the name *I. iridifolia* as well as *I. crocata*. Amongst these is a manuscript in Van Royen's hand where *Ixia iridifolia* is described. There are three drafts of the description and the final one, not dated, matches the published description almost exactly. It is possible that the type is amongst these specimens but no specimen can be chosen with certainty.

Miller's plant can perhaps be regarded as a lectotype as it was cited by de la Roche. It does not, however, match the description for it lacks branches and has somewhat different colouring. Because of this difference the present authors prefer to select a neotype. The specimen in Van Royen's Herbarium with which the manuscript was found matches the description best and this is proposed as the neotype.

De la Roche's mistake in considering *Ixia iridifolia* a new species is easy to understand, and perhaps justified. The description of *Ixia crocata* L. was published in the *Species Plantarum* ed. 2 vol. 1: 52 (1762) and contains a reference to Miller, *Icones*: t. 156 f.1. This illustration which is of *Ixia maculata*, does not quite tally with the description, but hardly suggests an error. In the second volume of this edition of the *Species Plantarum* (1763) Linnaeus describes *Ixia maculata*, referring to the same plate of Miller's *Icones*, leaving *Ixia*

*crocata* without any reference to its type. Thus, with the rather short description typical of Linnaeus, *Ixia crocata* was difficult to identify, and remained so, until a correction was published referring to a different illustration in Miller's *Icones*: 239 f.2 (Linnaeus 1767b). As it is possible to identify *Ixia crocata* with confidence, *Ixia iridifolia* must be considered a later synonym. The plant is now known as

***Tritonia crocata* (L.) Ker.**

14. *Ixia paniculata*.

This was illustrated by de la Roche (t.1) and its identity has never been in doubt. In the revision of *Ixia*, Lewis (1962) cites the illustration as a lectotype of *I. paniculata*. There is a plant in Van Royen's Herbarium strongly resembling the illustration, having amongst other similarities a four-branched inflorescence. This is perhaps the specimen from which the drawing was made, but as a lectotype has already been chosen this possibility can be ignored. Strictly speaking, de la Roche's illustration should have been designated a holotype since no other possible type material was then known. The presence in Van Royen's collection of the specimen which may have been the one illustrated, does however, vindicate the decision.

GLADIOLUS

The species of *Gladiolus* described by de la Roche have presented no problem as all three were illustrated (t. 2, 3, 4). The first two, *G. permeabilis* and *G. involutus* are well known species and appear to be known correctly by de la Roche's epithets.

There are specimens of these two species in van Royen's collection at Leiden, and with both are draft manuscripts of the descriptions which appear in de la Roche's thesis. As mentioned earlier, it appears that van Royen did not approve of de la Roche's descriptions and these were corrected and re-written by his tutor.

The illustrations can conveniently be regarded as holotypes. The specimens containing the draft manuscripts are possibly those from which the drawings were made. As this cannot be determined, the specimens cannot with certainty be regarded as types. They do, however, confirm the identity of the species.

*Gladiolus carneus* is recognised as a form of *G. blandus* Ait. (1789). The latter name was recognised by Baker (in Thistleton-Dyer, 1896) but *G. carneus* has priority. As this is apparently the oldest valid epithet for this species it is the one by which it must be known. There appears to be no specimen of this species in Van Royen's collection, and the illustration in de la Roche's thesis must be regarded as the holotype.

## VIEUSSEUXIA

This was a genus first described by de la Roche and he included in it three species now regarded as belonging to the genus *Moraea*. This genus is older than *Vieusseuxia*, having been mentioned by Linnaeus in 1762 and subsequently described in 1764. *Moraea* was only later described more fully in the Mantissa Plantarum (1767a) and only then did it become clear that *Vieusseuxia* was synonymous with it. De la Roche can perhaps be pardoned for rejecting *Moraea*, which at the time his thesis was published, was rather imperfectly understood. It is clear that he really agreed with Linnaeus about the existence of a South African genus resembling, but distinct from *Iris*, and the name he proposed, *Vieusseuxia* was only later found to be synonymous with *Moraea* of Linnaeus.

The thesis contains one gross typographic error. The names of *Vieusseuxia fugax* and *V. aristata* have been transposed in print. This error was recognised by the botanists who followed de la Roche, including Burman (1768), Jacquin (1776), Houttyn (1780) and Ker (1803) and Van Royen who corrected the error in the copy of the thesis sent to Linnaeus and annotated by him. The error is clear from the description of the flowers of the two species as printed:

*V. fugax* petalorum vero interiorum trium laciniae media aristata, rectae  
*V. aristata* flores lutei fugaces vix per trihorium persistentes

The above mentioned authors, realising the error changed the names round to read as they believed the author intended. Lewis (1948) discussed this problem and concluded that the names had to remain in the order in which they were published. According to the International Code of Botanical Nomenclature it appears that orthographic errors made by authors should remain as published but typographic errors should be corrected.

This error is clearly typographic, as not only do the descriptions fail to tally with the names, but the newly found manuscripts indicate conclusively that the names were transposed by the publishers.

1. *Vieusseuxia spiralis*

This is figured by de la Roche (t.5) and can be recognised as *Moraea bellendeni* (Sweet) N. E. Brown. There is one specimen of this species in Burman's collection but labelled *V. fugax*. The two specimens in Van Royen's collection, both bear the name *V. spiralis* and one is similar to de la Roche's illustration. As this is not certainly the type the illustration remains the holotype.

In the folder with this specimen are three draft descriptions of *V. spiralis* all in Van Royen's hand. The third, dated 15th August 1766, is the final description which was published. Again there is the question as to how much of the description was really written by de la Roche. In Van Royen's first draft, dated



June 1766, he writes "Royen apud de la Roche" i.e. Van Royen in the writings of de la Roche, which today we would interpret as Van Royen in de la Roche. It is, however, simpler and probably correct to credit de la Roche with authorship of this species and to regard Van Royen's contributions as corrections by his tutor.

Although it is the oldest name for this species, the transfer of *V. spiralis* to *Moraea* is barred by the occurrence of *M. spiralis* L.f. which is now known as *Aristea spiralis* (L.f.) Ker. The later synonym *V. bellendenii* Sweet, transferred to *Moraea* by N. E. Brown (1929) is now the correct name and *Vieusseuxia spiralis* de la Roche is correctly known as *Moraea bellendenii* (Sweet) N. E. Br.

## 2. *Vieusseuxia aristata*

De la Roche described this plant as being similar in habit to *V. spiralis* but about twice as large. He states that a dried specimen was provided by Van Royen. It is presumed that this was the same species as the specimen labelled *V. aristata* in the Van Royen collection, but probably not the specimen described by de la Roche, as there are several differences between the printed description and this specimen.

Two manuscripts were found in the folder with this specimen. One, in Van Royen's hand, is a draft of the published description and the other written in rather faint pencil and in a different hand appears to be an earlier draft. The Latin here is poor and often ungrammatical but the description is clearly the same in many respects to the Van Royen draft. A major difference is that the earlier author, presumably de la Roche, described the floral features in considerably more detail. The anthers and style structure are described so minutely that it is possible to identify the plant concerned as *Moraea gigandra*. This plant is peculiar in having large stamens which are longer than the style, and very short style crests, features quite unmistakably noted in this old manuscript.

In the final draft of the description the detail of the reproductive organs is ignored and they are described as being like *V. spiralis* which is not true of *M. gigandra* but is correct for the dried specimen in Van Royen's collection. Another alteration is that the claw of the outer perianth segments is described as hairy or bearded where the earlier draft merely states the colour (atro-violaceus).

It seems then that the earlier description was made of a different though similar species from the one Van Royen had in mind when he corrected and rewrote the final draft. This latter species was probably the same species as the dried specimen still in the collection. Van Royen's alterations were not however sufficient to avoid ambiguity, as several phrases from the earlier draft were left unaltered: the claw is described as dark purple and the markings on

the large outer perianth segments as concentric circles of yellow and purple, features which do not apply to the dried specimen. Thus *V. aristata*, as described, is somewhat ambiguous as it appears to be based on two different entities. Although it is clear that the description in the final form was intended to apply to Van Royen's dried specimen, the name should perhaps be discarded.

The actual identity of this dried specimen in Van Royen's collection is clear but the correct name is rather uncertain. The present authors agree with Lewis in identifying it with the very rare species of *Moraea* known only from the Observatory gardens in Cape Town. At present it is known as *Moraea tricuspidata* (L.f.) Lewis. In fact Lewis (1948) regarded *M. tricuspidata* and *V. aristata* (as *V. fugax*, because she did not consider the transposition of the two epithets as permissible) as synonymous. The name *Iris tricuspidata* on which *M. tricuspidata* was based, appears in the authors' opinion to apply to another species, at present known as *M. confusa*, a name chosen by Lewis for the plant previously known as *M. tricuspis* (Thunb.) Ker. This is actually identical to *M. tricuspidata* (L.f.) Lewis, for the younger Linnaeus altered Thunberg's epithet *tricuspis* slightly when he published that species a few years before Thunberg.

No changes in taxonomy are proposed here, however, for the authors feel that this group of species of *Moraea* are as yet rather imperfectly known and until further studies are made, it would be premature to suggest any changes to the nomenclature.

### 3. *Vieusseuxia fugax*

Erroneously transposed with *V. aristata* in the published thesis, the species to which the name correctly applies is at present known as *Moraea edulis* (L.f.) Ker. De la Roche cites Van Hazen, Catal. Arb. & Plant. p. 67, a commercial horticultural catalogue in which the species was illustrated. There is no specimen of the species in Burman's Herbarium but there are two at Leiden and one bearing the name of *V. fugax* which is not this species. Again there is a draft description by Van Royen which somewhat resembles the published description. On this manuscript which is not dated, Van Royen has added "*Moraea suaveolens* 1777" and he appears to have decided that this species was a *Moraea*. There is also a draft description of "*Moraea suaveolens*" dated 1780 but this was never published.

As there is no evidence that either specimen at Leiden is the type, Van Hazen's illustration must be chosen as a lectotype. The typographic error occurring in the thesis must be corrected and the plant at present named *Moraea edulis* must be known by the older epithet. The transfer of *Vieusseuxia fugax* to *Moraea* had already been made in 1776 by Jacquin several years before *Iris edulis* L.f. was described. The taxonomic treatment is as follows



*Moraea fugax* (de la Roche) Jacquin, Hort. Vindob. 3: 14 t. 20 (1776)

*Vieusseuxia fugax* de la Roche Descr. Pl.: 33 (1766)

Lectotype: van Hazen, Catal. Arb. & Pl.: 67 (1759)

*Iris edulis* L.f. Suppl. Pl.: 98 (1781) Holotype: Herb. Linn. 61/21 (microfiche)!

*Moraea edulis* (L.f.) Ker in Bot. Mag.: t. 613 (1803).

#### ACKNOWLEDGEMENTS

The authors wish to thank the curators of the Rijksherbarium, Leiden, and the Delessert Herbarium, Geneva, for the loan of the specimens and manuscripts used in this study. Thanks are also due to the Council of the Linnaean Society for copies of several old manuscripts, the curator of the Compton Herbarium, Kirstenbosch, for making available specimens for study and for the loan of a copy of de la Roche's thesis, to Professor E. A. Schelpe for his advice and useful criticism and to Mr. A. Fricke for help in preparing the plates.

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**H. M. L. BOLUS, (1877—1970)**

Harriet Margaret Louisa Bolus was born at Burgersdorp in the Cape Province on the 31st July 1877. Her father William Kensit, a Londoner by birth, came to South Africa as a child. Her mother, Jane Stuart, was of Scottish descent and William Kensit was her second husband. Louisa, her mother's thirteenth child, was but two years old when her mother died, leaving William Kensit to look after his young family of six. There was a strong bond of affection between father and daughter and during the later years of his long life, she devoted herself to his care.

She received the early part of her education in Port Elizabeth. There the motherless girl had the good fortune to come under the influence of two inspiring teachers, Miss van Wyk and Miss Molteno. Louisa owed much to these women. She matriculated in 1898 and the following year took a teacher's course obtaining a first class pass. The next three years were spent studying at the South African College where at the end of the period she obtained an honours degree in Arts. Had there been a department of Botany at the college, she might well have taken a course during her years as an undergraduate for at this time, whenever she was able, she was helping her uncle, Harry Bolus, in his herbarium. A knowledge of Botany would have been of great use to her, but no training in Botany was available and it was from her uncle that she learned the elements of floral structure and plant classification. Latin had been one of the major subjects studied for her degree, and the knowledge she then obtained stood her in good stead in the years to come. The average botanist is poorly equipped to produce descriptions of new plants in acceptable Latin. A task such as this presented no difficulty to Louisa Kensit and she may well hold a record among modern botanists for the many hundreds of new species she described in Latin.

So satisfied was Harry Bolus with his apt pupil that in 1903, the year after she had obtained her degree, he appointed her as curator of his herbarium. She never forgot the debt she owed him for it was he who had sponsored much of her education and had roused interest in what was to be her life's work. On his death in 1911 the much cherished herbarium and library were left to the South African College. It was stipulated in the will that Louisa Kensit was to be curator of the herbarium during her lifetime or until, for reasons of



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age or ill-health, she wished to relinquish the task. In 1955, at the age of 78 she decided that the time had come to hand over the work entrusted to her. Ceasing to be Curator did not, however, cause her to sever her connection with the herbarium. The University made her an Honorary Reader in Plant Taxonomy and, until about a year before her death, she was a constant visitor, working in a specially reserved area on the top floor of the herbarium, surrounded by cabinets containing the specimens she had named and preserved for future generations. Her last publication, under the title of "Notes on Mesembryanthemum and Allied Genera", appeared in the *Journal of South African Botany* in May 1969 and it is characteristic of her indomitable spirit that at the conclusion of the article appeared the usual "(to be continued)". This was not to be. During the last months of her life she was confined to her home in Claremont where she died on the 5th April 1970.

Her earliest botanical work was helping her uncle to complete his monumental work on the Ericaceae for the *Flora Capensis*, the part containing it appearing in 1905. In it Harry Bolus acknowledged the assistance he had had from his niece. Her interest in this large family continued after his death and she described and published a number of new species under her own name.

Harry Bolus's other great interest lay in the orchids of South Africa. Volume I of his work on this group had been published before his niece became his assistant but in the preparation of Volume II she played a considerable part. During this period Harry Bolus's health was failing and he died before it appeared in print but not before he had acknowledged his debt to Louisa Kensit. He had left notes and illustrations for Volume III but these were incomplete. So this final volume was prepared for publication by her with help from Frank Bolus, his son, whom she had married in 1912. Frank Bolus had inherited his father's artistic ability and was able to prepare some plates necessary for the completion of the work. Undoubtedly she supervised these additional illustrations though she was not able to carry out the work herself.

The inability to prepare her own illustrations was a handicap but in the early stages of her botanical career friends came to her aid. Later the Bolus Herbarium employed an artist whose main function was to illustrate new species. Names of artists such as M. W. Glover, Dorothy Barclay, M. Page and B. O. Carter are associated with many of her early plant studies. It was indeed a lucky day for botanical illustration in South Africa when she discovered Mary Page, who had come to South Africa in search of health and was occupying herself painting South African scenes and plants. Her plant sketches showed such obvious talent that Mrs. Bolus invited her to live with her for three months and train as a botanical artist. During that time she was instructed in the art of botanical illustration. The success of this venture may be gauged by a reference to Mary Page in Wilfrid Blunt's "The Art of Botanical Illustration".

tion" where she is quoted as one of the outstanding botanical artists of her day. Unfortunately rising costs of living coupled with the inelastic income of the Bolus Herbarium made the employment of an artist impossible after the death of Miss B. O. Carter. Thus most of the later descriptions of plants prepared by Mrs. Bolus are strictly for the botanical specialist for they are in Latin and have no illustrations to guide the uninitiated.

In her early days as a botanist she devoted herself to the heaths and orchids which had been her uncle's main interest. Soon, however, the scope of her studies widened and she became attracted to the Iridaceae. At this time too she became aware of the gaps in our knowledge of the unwieldy genus *Mesembryanthemum* and descriptions of new species appeared from time to time, many of them under the title "*Novitates Africanæ*" in the short lived *Annals of the Bolus Herbarium*. In 1925 a paper by N. E. Brown of Kew appeared in "*The Gardener's Chronicle*" in England and this had a profound influence on her future work. In it N. E. Brown pointed out that under *Mesembryanthemum* several groups of plants were included, each deserving elevation to generic rank. He promptly proceeded to separate these discordant elements and name them, a process which he continued for many years and his name therefore appears as the author of a very large number of new generic names. Schwantes in Germany was not slow to take up the challenge and he too added new genera. Mrs. Bolus agreed with the desirability of splitting *Mesembryanthemum* into smaller units but the urge to create new genera herself was not great. When the enormous number of new species created by her is considered, the number of new genera bearing her name as the authority, is surprisingly small. When the *Annals of the Bolus Herbarium* ceased to exist, she continued to publish new species in *South African Gardening and Country Life* and in *Nature Notes*. This scattering of scientific descriptions in rather inaccessible journals did not receive the approval of her scientific co-workers and she therefore decided to publish all her new species in this specialised field in a new series to be styled "*Mesembryanthemum and allied Genera*". These descriptions which appeared from time to time from 1927 to 1958, were published in three parts by the University of Cape Town. From 1960 to 1969 the descriptions were continued under the same title in the *Journal of South African Botany*.

It is somewhat surprising that in a life devoted to this most interesting group of plants, a group teeming with problems not only taxonomic but also physiological and ecological, she attracted few fellow workers. However there was no slackening off in the numbers of specimens sent to her for study by her many admirers and often they were delighted to find their names perpetuated in new species or, on rare occasions, new genera. It is possible that co-operation with her was discouraged by her rigid views as to how botanical studies should be carried out and along these chosen lines her standards were high. M. Lavis

(later Mrs. O'Connor-Fenton) was her chief assistant and was still helping at the time of her death. A stray remark made by her many years ago perhaps explains the enigma of this lone, indefatigable worker. In discussing a paper given to the South African Association for the Advancement of Science in which the lecturer had attempted to group according to affinity the species of a large genus, she remarked with some heat that such papers were a shocking waste of time. What mattered were the species themselves, their correct description and illustration. A theoretical discussion such as the one we had just heard was valueless. This perhaps explains why in her long life she described something in the neighbourhood of seventeen hundred species and never attempted any real synthesis. The way laid down by Harry Bolus was clear and for her there was no deviation.

She regarded her curatorship as a sacred trust. Her uncle's views were to be respected and his wishes carried out in spite of changes in outlook which inevitably took place after his death. She found it difficult to adapt herself to such changes and they were often the cause of personal unhappiness in later years when she was no longer in control of the herbarium and had to watch changes taking place, changes of which she was sure Harry Bolus would not have approved.

In the years which followed her uncle's death and before her work on *Mesembryanthemum* caused her to direct her energies into one main channel, her interests were wide. Her training as a teacher made her realise the importance of making contact with young people and making them interested in nature study. The founding of Kirstenbosch was a source of great joy to her and in its early days she was often to be seen conducting groups of children round the Garden. In fact she has a good claim to be regarded as the originator of Nature study classes there, classes which to-day play an important role in the education of schoolchildren. In 1919 she published a small booklet with the title "Elementary Lessons in Systematic Botany". This was followed some years later by two more ambitious books under the titles "A Book of South African Flowers" and "A Second Book of South African Flowers". These had coloured illustrations prepared by Dorothy Barclay and photographs by E. J. Steer.

Anything to do with nature conservation found in her an enthusiastic worker. Kirstenbosch and its founder had a special place in her affection. Thus the Botanical Society which was founded to provide funds for the development of Kirstenbosch, had in her one of its earliest supporters. She served on its Council until in 1956 she resigned on account of age. She was created an Honorary Life Member as an appreciation of her services to it and the Gardens. She was a founder of the Wild Life Protection Committee and one of its most enthusiastic members. Everything that had to do with the plant life of South Africa and its preservation found in her a doughty champion. The love of nature inculcated

by her uncle remained with her to the end a guiding light in a world that seemed to her to have lost its way to peace and serenity.

Recognition of her services to Botany were given on several occasions. The University of Stellenbosch was the first to appreciate her unique contribution to knowledge when they awarded her an honorary D.Sc. degree in 1936. About ten years before her death she had the honour of being elected to membership of the International Organisation for Succulent Plant Study (I.S.O.), a privilege afforded a limited number of persons distinguished in this particular field. In 1966 when the African Succulent Plant Society was founded, she was elected as vice-president in honour of her achievements. Only two months before her death she was made an honorary Life Member of the recently established South African Association of Botanists. These honours, many coming towards the end of a long life, must have made her feel that her contributions to knowledge of the South African Flora were appreciated by fellow workers.

Those of us who knew her in the years soon after her uncle's death, remember a short, rather plump, dynamic person, vigorous in body and mind. It may surprise many who knew her only in more recent years, to learn that she was an early member of the Mountain Club of South Africa and was never happier than when climbing mountains in search of plants. Early specimens collected by her and now stored in the Herbarium, bear evidence of her as a field worker at that time. Serious damage to an ankle, sustained in her middle years, prevented her from indulging in these much loved activities and she was forced to rely for her studies on plants brought to her by other people. Though she could no longer explore the veld, she still led an active life, relying more and more on her motor car to carry her from place to place. Her small car was a familiar sight on the roads between her house and the Bolus Herbarium. With advancing years she became thinner and appeared to shrink in height. Her diminutive size was especially noticeable when she was driving her car and one member of her staff remarked "If you see a small car proceeding slowly in the middle of the road and without an apparent driver, then you may be sure the driver is Mrs. Bolus".

Her memory will be perpetuated by the many contributions she made to plant taxonomy. Her record is one of amazing industry coupled with an unswerving devotion to the memory and ideals of Harry Bolus. When she finally handed over the care of the herbarium to others, she left it much increased in size, with its specimens well housed and its valuable collection of books in good condition. Harry Bolus knew well what he was doing when he left his niece as guardian of the collection. For close on sixty years after his death she lived for and often fought for the welfare of the collection entrusted to her. Even those who at times came under the whip-like lash of her tongue, can but admire her proud record of courage and tenacity of purpose. Seldom can an uncle have had a more devoted niece.

Now she has gone and the care of this valuable collection devolves upon the University of Cape Town. The responsibilities are great but so are the rewards. A priceless bequest such as this, must enhance the prestige of the University to which it was entrusted.

M. R. Levyns

A LIST OF PUBLICATIONS BY H. M. L. BOLUS

Compiled by J. P. Jessop

While every attempt has been made to make this list as complete as possible, omissions are likely as Mrs. Bolus did not keep a list herself. The list was submitted to her for comments in 1962 and she was able to add a few references then.

Only articles which are signed, and are therefore identifiable with certainty, could be included.

1908. *Mesembrianthemum Pillansii*. Kentsit nov. sp. In: Ém. de Wildeman. *Plantae Novae vel minus cognitae ex Herbario Horti Thenensis*. 2: plate 57. Bruxelles.
1909. With H. Bolus. Contributions to the African flora. *Trans. R. Soc. S. Afr.* 1: 147–163.
- 1911a. Harry Bolus, D.Sc., F.L.S. (1834–1911)—appendix I; Botanical journeys in South Africa. *S. Afr. J. Sci.* 8 (3): 77–78.
- 1911b. Harry Bolus (1834–1911). *J. Bot., Lond.* 49: 241–243.
- 1913a. In: H. H. W. Pearson. Plants collected in the Percy Sladen Memorial Expeditions, 1908–9, 1910–11. *Ann. S. Afr. Mus.* 9: 131–158, 160–170, 175, 178–183.
- 1913b. Editor: H. Bolus. *Icones Orchidearum Austro-Africanarum Extra-Tropicarum*. Vol. III. London: William Wesley and son.
- 1914a. With F. Bolus & R. Glover. On the flora of the Great Karasberg. II. List of plants collected. *Ann. Bolus Herb.* 1: 9–19, 72–75.
- 1914b. Novitates Africanarum. *Ann. Bolus Herb.* 1: 20–21, 76–77.
- 1914c. With F. Bolus. Key to the flora of the Cape Peninsula. *Ann. Bolus Herb.* 1: 22–35.
- 1915a. In: H. H. W. Pearson. Plants collected in the Percy Sladen Memorial Expeditions, 1908–9, 1910–11. *Ann. S. Afr. Mus.* 9: 214–226, 246–272.
- 1915b. With F. Bolus & R. Glover. On the flora of the Great Karasberg. II. List of plants collected. *Ann. Bolus Herb.* 1: 97–114.
- 1915c. Novitates Africanarum. *Ann. Bolus Herb.* 1: 127–133.
- 1915d. With F. Bolus. Key to the flora of the Cape Peninsula. *Ann. Bolus Herb.* 1: 116–125, 173–184.
- 1915e. Notes on *Lessertia* with descriptions of six new species and a key. *Ann. Bolus Herb.* 1: 87–96.
- 1915f. Notes on imperfectly known species. *Ann. Bolus Herb.* 1: 133.
- 1916a. Novitates Africanarum. *Ann. Bolus Herb.* 2: 28–32.
- 1916b. Editor of *Ann. Bolus Herb.* 2, pts 1 & 2.
- 1917a. Novitates Africanarum. *Ann. Bolus Herb.* 2: 96–97.
- 1917b. Native trees and tree-shrubs of Kirstenbosch. *J. bot. Soc. S. Afr.* 3: 12–22.
- 1917c. Editor of *Ann. Bolus Herb.* 2, pt. 3.
- 1917d. *Mesembryanthemum Pillansii*. Curtis's bot. Mag. 143: t.8703.
- 1918a. With A. M. Greene. Editors: H. Bolus. *The Orchids of the Cape Peninsula*. Cape Town: Darters.
- 1918b. Novitates Africanarum. *Ann. Bolus Herb.* 2: 153–161.
- 1918c. With E. P. Phillips. The South African heaths. *J. bot. Soc. S. Afr.* 4: 2–4.
- 1918d. A note on the native and cultivated heaths of Kirstenbosch. *J. bot. Soc. S. Afr.* 4: 5.
- 1918e. Editor of *Ann. Bolus Herb.* 2, pt. 4.
- 1919a. *Elementary Lessons in systematic Botany based on familiar Species of the South African Flora*. Cape Town: Maskew Miller.
- 1919b. With M. Beghin & V. Halm. Notes on Kirstenbosch Leguminosae. *J. bot. Soc. S. Afr.* 5: 17–19.

- 1920a. With R. Wordsworth, J. Hutchinson and F. Bolus. Flowering plants collected in South West Africa by the Percy Sladen Memorial Expedition, 1915–1916. *Ann. Bolus Herb.* 3: 15–37.
- 1920b. Novitates Africanæ. *Ann. Bolus Herb.* 3: 4–7, 9–14.
- 1920c. With J. W. Mathews. Notes on the supplementary plate. *J. bot. Soc. S. Afr.* 6: 7–8.
- 1920d. Notes on Compositæ. *J. bot. Soc. S. Afr.* 6: 9–11.
- 1920e. Editor of *Ann. Bolus Herb.* 3, pt. 1.
- 1921a. Novitates Africanæ. *Ann. Bolus Herb.* 3: 70–80.
- 1921b. South African Proteaceæ. *J. bot. Soc. S. Afr.* 7: 13–15.
- 1921c. Mammals at Kirstenbosch. *J. bot. Soc. S. Afr.* 7: 19–21.
- 1921d. Editor of *Ann. Bolus Herb.* 3, pt. 2.
- 1922a. Novitates Africanæ. *Ann. Bolus Herb.* 3: 123–142.
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- 1922i. Piet-mijn-vrouw, Christmas bird, red-chested Cuckoo, solitary cuckoo. (*Cuculus solitarius*, Steph.). *S. Afr. Gdng Ctry Life* 12: 456–457.
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- 1923i. Olive thrush or Cape thrush (*Turdus olivaceus*, L.). *S. Afr. Gdng Ctry Life* 13: 93.
- 1923j. The grey heron (*Ardea cinerea*, L.). *S. Afr. Gdng Ctry Life* 13: 131, 134.
- 1923k. The black-shouldered kite (*Elanus caeruleus*, Gurney). *S. Afr. Gdng Ctry Life* 13: 175.
- 1923l. The speckled pigeon (*Columba phaeonota*, G. R. Gray). *S. Afr. Gdng Ctry Life* 13: 225.
- 1923m. The noisy francolin or Cape pheasant (*Francolinus capensis*, Gmel.). *S. Afr. Gdng Ctry Life* 13: 365, 375.
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- 1927c. Plants—new and noteworthy. *S. Afr. Gdng Ctry Life* **17**: 177–178, 241, 253, 293, 294, 336–337, 374–375, 416–418, 449–450.
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- 1927f. Many contributions to *Nature Notes* 5.
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- 1927h. Yellow-petticoat heath (*Erica Thunbergii*, Montin.). *S. Afr. Gdng Ctry Life* **17**: 158.
- 1927i. Caledon bluebell (*Gladiolus spathaceus*, Pappe). *S. Afr. Gdng Ctry Life* **17**: 215.
- 1927j. Walker's heath (*Erica Walkeria*, Andr.). *S. Afr. Gdng Ctry Life* **17**: 257.
- 1927k. South African succulents: *Mesembrianthemum* and allied genera. *S. Afr. Gdng Ctry Life* **17**: 238–239, 256, 280–281, 326–327, 364–365, 398–399, 433–435.
- 1927l. Sphaeroids, dumplings, buttons. *Conophytum*, N. E. Brown. *S. Afr. Gdng Ctry Life* **17**: 294–295, 334–335, 372–373, 410–411, 446–447.
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- 1928q. *Hereroa Tugwelliae*, L. Bolus. *S. Afr. Gdng Ctry Life* **18**: 253.
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## BOOK REVIEWS

**PRINCIPLES OF DISPERSAL IN HIGHER PLANTS** by L. van der Pijl, vii plus 154 pages (11 being indices, 7 reference lists), 26 illustrations. Berlin—Heidelberg—New York: Springer-Verlag, 1969.

In 136 pages of text the author gives a compact yet wide-ranging account of the principles underlying dispersal of higher plants and the means by which this is brought about. He regards it chiefly from an ecological point of view, unlike the previous mainly morphological studies. Though the language at times requires considerable thought, the writer is, in the main, to be congratulated on his precise English. He wastes no words, uses many short sentences and, discussing principles, keeps examples to illustrate these to a minimum, usually one only. In an attempt to tidy up terminology and explain his own usages, the author reviews words used in earlier works. He also (rightly) roundly condemns fruit classification as it exists today but admits he himself could not do better. For those with little classical background, the going will be hard as terms multiply in this expanding subject, yet words such as ombrohydrochory and atelechory are necessary and convenient shorthand in this book and in whatever language the subject is discussed.

Diaspores or units of dispersal, are defined on pp. 8–12 and the relation between flowers, fruits and seeds is discussed in Chapter IV. Dispersal is dealt with first under the agents bringing it about; comprehensively covered under eleven types of agent, even the 'black-jack' is given a place (pp. 68 & 90). In sub-sections under the various agents, the means by which diaspores (or reproductive bodies of plants) attain dispersal are given. The following chapter discusses combination, limitation and co-operation in the process of dispersal and Chapter VIII gives the necessary corollary to dispersal—establishment. Evolution of the various organs of dispersal is next treated and a brief discussion of the seed is given. (The word angiosperm is criticised as inaccurate, the ovule rather than the seed being enclosed; dehiscence and escape are necessary for the seed. However, the author himself uses the phrase 'Megasporeangia (or seeds)' on page 101, which seems a strange misuse of terminology by one otherwise so exact.)

Following this there is an interesting summary of the ecological development in leguminous fruits and finally, Chapter X deals with 'Man and his Plants'. Weeds are the chief of these anthropophytes and of all countries New Zealand seems to have the most, (about a thousand) mainly brought by man's activities.

The illustrations, whether photographs or line drawings, are very clear and aid the text; one photograph, however, seems reversed (fig. 26, p.130) and with the word 'Israël' misspelled. Other printer's or author's spelling errors are few—a scant dozen or so have been noticed together with one faulty page reference in the index (atelechory—p.31). As a text-book for Angiosperm biology, this companion volume to 'The Principles of Pollination Ecology' (Faegri and van der Pijl) is decidedly worthwhile and unique in its range and depth. The author acknowledges his indebtedness to Ridley's encyclopaedic 'The Dispersal of Plants Throughout the World' but rightly points to advances made since 1930. Though comprehensive and dealing with principles, this present work is not beyond intelligent observation to prove and to extend; it seems an essential text on university library shelves as well as elsewhere—South Africa has neglected the biology of its rich flora for too long.

A. JACOT GUILLARMOD

**GRASS—A STORY OF FRANKENWALD** by Edward Roux  
Oxford: University Press, 1968, Price R5.25 (52s. 6d.)

Frankenwald lies 12 miles to the north of Johannesburg on the main Pretoria road. The future of Frankenwald as a research station is somewhat uncertain as it is probable that a new university campus will be established on this site. This book, telling the story of Frankenwald as a field research station of the University of the Witwatersrand is therefore most timely.

This is the story of a research station that has played a leading role in the fields of ecology and pasture management in Southern Africa, but though students and other research workers play important parts in the book, there is only one star—"Grass".

In a style that will please most readers, particularly non-botanists, the author discusses the origin of grass and the role it plays in the world today. Its evolution, morphology,

physiology and ecology are presented simply and clearly and at no time does Professor Roux assume the reader to be a botanist.

He takes the reader on a quick journey through the Highveld as it was seen by the Voortrekkers. He reveals the effect man and his animals have had on the natural vegetation from the early "Stone Age" days up to the present.

The chapters that follow are based on the researches that were carried out at Frankenswald over a period of 35 years. Professor Roux uses the investigations of students as a vehicle for his biological excursions. His discussions on pre-rain flora, bird and animal life, termites and dung beetles, soil microbes and antibiotics are little masterpieces and the accompanying illustrations are excellent.

The theme that runs through the book is the ecological evergreen, secondary succession. Like the well constructed "Who Done It" the reader is presented with all the facts (experimental and otherwise) and in the penultimate chapter the author sums up all the evidence and then leads the reader to a possible conclusion. All ecologists will find the chapters on grassland succession both informative and provocative.

The South African Turf Research Station is sited at Frankenswald and its story is told in the chapter headed "Better Turf". Many of the findings from researches carried out here have led to better playing surfaces for the many sports conducted in South Africa.

The evergreen problems of veld burning, bush encroachment, soil structure, grazing and over-grazing, soil erosion and fertilizing veld are all given an airing and the value of the continuity in research is most apparent.

This is a book that will appeal to all persons interested in nature conservation while it is a must for all practising botanists and university students studying biology. The book is never dull or over-technical and has all the necessary requisites of a classic. It should have a wide and long-lasting appeal.

R. E. ALTONA

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